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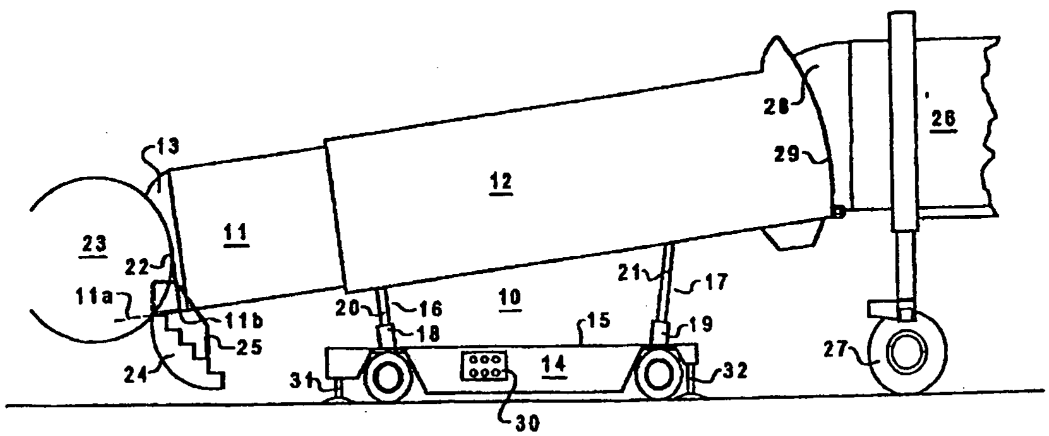
(54) **PONT D'EMBARQUEMENT POUR PETITS AVIONS ET METHODE D'ALIGNEMENT DE CELUI-CI**

(54) **PASSENGER LOADING BRIDGE FOR SMALL AIRCRAFT AND METHOD OF ALIGNING SAME**



(57) Cette invention concerne un pont d'embarquement adapté pour permettre le transfert des passagers depuis le rez-de-chaussée d'une aérogare à un avion de transport régional à garde au sol comprise entre 40 pouces et 108 pouces ou plus. Le pont comprend une rotonde pivotante et une passerelle se prolongeant jusqu'à l'avion. La passerelle est montée sur un chariot dont les roues sont parallèles à l'axe de la passerelle et qui est équipé de vérins hydrauliques de levage d'une partie de la passerelle. En position abaissée, la passerelle repose entre les roues du chariot. L'avion se stationne perpendiculairement à la passerelle, sa porte d'accès étant dans le prolongement de la partie télescopique de celle-ci. Cette partie télescopique est inclinée vers le bas par rapport au point le plus élevé du pont lorsqu'il s'agit d'assurer le transfert des passagers dans un très petit avion.

(57) A passenger loading bridge is disclosed for bridging passengers between a ground floor terminal and commuter aircraft from as low as 40 inches to as high as 108 inches or higher. The bridge has a rotating rotunda and walkway extending therefrom to an aircraft. The walkway is supported by a gantry having wheels directed laterally to the walkway and on opposing sides thereof and a hydraulic lifting mechanism for lifting and lowering an end of the walkway. When lowered, the walkway rests between the wheels. The aircraft interface is at right angles to the walkway and is on an extensible section of the walkway. The extensible section of the walkway angles down from the walkway's highest point when the walkway is completely lowered allowing for bridging from a ground level terminal to very small aircraft.

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Abstract of the Disclosure

A passenger loading bridge is disclosed for bridging passengers between a ground floor terminal and commuter aircraft from as low as 40 inches to as high as 108 inches or higher. The bridge has a rotating rotunda and walkway extending therefrom to an aircraft. The walkway is supported by a gantry having wheels directed laterally to the walkway and on opposing sides thereof and a hydraulic lifting mechanism for lifting and lowering an end of the walkway. When lowered, the walkway rests between the wheels. The aircraft interface is at right angles to the walkway and is on an extensible section of the walkway. The extensible section of the walkway angles down from the walkway's highest point when the walkway is completely lowered allowing for bridging from a ground level terminal to very small aircraft.

Passenger Loading bridge for Small Aircraft and Method of Aligning Same

Field of the Invention

The invention relates generally to passenger loading bridges and, in particular, to a swinging-type passenger loading bridge for use at ground level airport terminals.

Background of the Invention

Passenger loading bridges have gained world-wide acceptance for the safety and convenience they afford passengers. Most major air terminals are provided with passenger loading bridges which extend from the second level of the terminal to a parked aircraft. Frequently, these bridges are relatively immobile since aircraft can park close to the terminal and be moved away by tugs or tractors.

Commonly, passenger loading bridges have been directed to standard size passenger and cargo aircraft and consequently, have been relatively large in size and height. They have not generally been practicable for use with small aircraft such as, those employed in feeder lines to smaller or outlying communities. Accordingly, persons emplaning or deplaning to and from small aircraft typically have had to walk from a doorway or the like over airport tarmac and thence. up a stairway in order to enter a small aircraft. When deplaning, just the reverse occurs, thus exposing passengers to inclement weather and hazards such as propellers, cables, and fuelling hoses. Therefore, there has continued to be a need for a highly adjustable and enclosed passenger or cargo loading/unloading bridge that can be advantageously utilised with such small aircraft.

Commonly, smaller air terminals are only ground level structures at which aircraft park a fixed distance from the terminal building. There frequently are no tugs available. This fixed distance is required to enable the aircraft to "power out" or move away from the building under its own power without damaging the building with a jet or propeller blast, or a physical collision between the aircraft and the terminal. This distance is

greatest with a Boeing 727-200 aircraft, which is the largest aircraft normally serving these smaller terminals. Passengers walk in the open out to the aircraft and up an open staircase into the plane. It is not desirable to subject passengers to inclement weather or to potentially dangerous ramp conditions. Also, aircraft operations are significantly slowed by allowing passengers onto the tarmac. For safety reasons, aircraft and equipment remain stationary while passengers are on the tarmac. Security is a concern because passengers can board incorrect aircraft or tamper with other craft. In order to increase security, it is a common practice to board only one aircraft from the tarmac at any time. With passenger loading bridges in place, luggage is loaded, aircraft tests are executed, other aircraft are taxied, and so on while passengers board the aircraft. Other aircraft are capable of being boarded simultaneously when sufficient gates exist. It is therefore desirable to provide a passenger loading bridge for use at these smaller air terminals to enhance the safety and comfort of passengers.

A prior art type-of ground level loading bridge is shown in U.S. Pat. No. 3,110,048 in the name of Bolton, which illustrates a bridge having a rotunda, tunnel, stairs to aircraft level, and a tunnel which extends to the aircraft. The juncture of the stairs and the tunnel is provided with an arcuate track with co-operating wheels to support the load of the bridge. The wheels are provided with mean to elevate the entire tunnel and stairs to accommodate different aircraft. Of course, such a structure is undesirable because of limited access for the physically disabled and other liabilities associated with stairs.

When ramps for planing and deplaning mate with an opening in a second floor of an airport terminal, the height of the two ends of the ramp are most conveniently aligned when the ramp is to an entrance of a jumbo jet - both being a similar distance from the ground. Because of the small size of many commuter aircraft, a ramp from a ground level terminal to the entrance of a small aircraft must have both openings near ground level. Unfortunately, the height of other commuter aircraft requires a ramp from ground level to

9 feet from the ground. Because of the mechanism for moving and lifting the ramp, ramps can not lower themselves sufficiently to function from a ground level entrance of a terminal to an entrance of a small commuter aircraft.

In U.S. Patent 4,161,049 issued to Saunders et al. on July 17, 1979, a passenger loading bridge for a ground level terminal is disclosed. In order to accommodate small aircraft, a stairway from a rotunda to a walkway is provided. The stairway permits an end of the walkway proximate the terminal to be raised to or above the minimum height of the supports for raising and lowering the walkway proximate an aircraft and therefor allows the walkway to mate with aircraft entrances that are disposed in line with the minimum support height. As indicated above, it is undesirable to provide stairs for passenger use in a passenger loading bridge. Replacing the stairs with a ramp results in a steep ramp that is itself undesirable or in an unduly long ramp. Further, replacing the stairs with a long ramp results in forces being applied to the rotunda which will increase wear on rotating parts and, in some instances, will result in failure of the rotating mechanism.

It would be advantageous to provide a passenger loading bridge that is capable of mating with an airport at ground level and with small and large commuter aircraft.

When coupling available passenger loading bridges to aircraft such as jumbo jets, a significant clearance exists between the engines and the aircraft entrance. Also, as the entrance to a jumbo jet is displaced from the ground by a considerable distance, collisions with personnel, baggage, or vehicles on the ground is unlikely. In contrast, the entrance for a Dash 8 is less than 4 feet from the ground. An aircraft interface approaching the entrance is susceptible to damaging vehicles and hurting people. Also, because a small aircraft has significantly less clearance between the propellers and the entrance than jumbo jets, current passenger loading bridges require several people to guide them into an

engaged position. Even with the efforts of a number of people, damage to the aircraft is likely due to very small clearance distances.

It would be advantageous to provide a passenger loading bridge that reduces a likelihood of damaging an aircraft and increases personnel safety.

Statement of the Invention

In accordance with the invention, there is provided a passenger loading bridge for interconnecting an aircraft having an entrance therein with the ground level of an airport terminal building comprising:

a walkway-conduit including:

a first open end,

an extensible section proximate an opposing end thereof comprising an aircraft interface for mating with the aircraft entrance,

elevation means for elevating the aircraft interface to allow the aircraft interface to engage each of a plurality of different sized commuter aircraft,, and

horizontal pivot means for pivoting the walkway about a rotunda;

the rotunda having a first open end coupled to the airport terminal building substantially at ground level and a second open end movable relative to said first open end of the rotunda, the second open end hingedly connected to the first open end of the walkway for allowing the rotunda to remain substantially level and for allowing the aircraft interface to be elevated, wherein the horizontal pivot means is for moving the second open end of the rotunda relative to the first open end of the rotunda..

In an embodiment, the walkway comprises:

a first walkway portion hingedly coupled to the rotunda;

a second walkway portion hingedly connected to the first walkway portion for allowing the second walkway portion to angle downwardly from the hinged connection, the second walkway portion having the aircraft engaging opening disposed proximate an end thereof; and, wherein the elevation means is disposed to raise and lower the walkway such that the hinged connection between the first and second portions forms an obtuse angle peak the walkway descending from the peak toward either side when the walkway is fully lowered.

In another embodiment, the walkway comprises:
a first walkway portion hingedly coupled to the rotunda; and,
a second walkway portion connected to the first walkway portion and angling downwardly from the connection, the second walkway portion having the aircraft interface disposed proximate an end thereof.

In an embodiment, the first opening of the rotunda is connected to two substantially circular rails disposed one above the other and wherein the second opening in the rotunda is connected to a plurality of bearings disposed between the rails and for rolling on either the bottom rail or the top rail.

Preferably, the two rails forms a fixed base for the rotunda relative to the ground.

In an embodiment, the aircraft interface comprises a bumper disposed along the bottom of the interface for engaging the aircraft, a gasket disposed substantially above the opening for engaging the aircraft above the opening and for forming a protective covering for passengers passing between the aircraft and the passenger loading bridge.

In an embodiment, the bottom of the aircraft interface comprises a plurality of slots for accepting railings disposed on staircases affixed to aircraft.

In accordance with the invention there is further provided a passenger loading bridge for interconnecting an aircraft having an entrance therein with the ground level of an airport terminal building comprising:

a walkway conduit including:

a first opening at an end thereof,

an extensible section proximate an opposing end thereof comprising an aircraft interface for mating with the aircraft entrance,

elevation means for elevating the aircraft interface to allow the aircraft interface to engage each of a plurality of different sized commuter aircraft,

horizontal pivot means for pivoting the walkway about a rotunda, and

sensors for detecting the presence of an object proximate the walkway and for providing signals in dependence thereon;

the rotunda having a first opening connected to the airport terminal building substantially at ground level and a second opening movable relative to said first opening of the rotunda, the second opening hingedly connected to the first opening in the walkway for allowing the rotunda to remain substantially level and for allowing the aircraft interface to be elevated, wherein the horizontal pivot means is for moving the second opening of the rotunda relative to the first opening of the rotunda; and,

means responsive to the signals provided by the sensors for stopping at least one of the horizontal pivot means and the elevation means when an object is detected in a path of motion of the walkway.

According to another aspect of the invention, there is provided a method of automatically aligning an aircraft interface of a passenger loading bridge and an entrance to an aircraft comprising the steps of:

determining an approximate height of the entrance;

moving the aircraft interface to substantially the approximate height;

moving the aircraft interface toward the aircraft;

detecting a presence of objects in the path of movement of the passenger loading bridge using sensors;

when possible, moving portions of the passenger loading bridge to avoid detected objects;

when objects cannot be avoided, stopping the passenger loading bridge motion until objects are cleared;

upon approaching the aircraft, aligning a bumper of the aircraft interface with the entrance; and

moving the aircraft interface to engage the aircraft with the bumper.

Brief Description of the Drawings

An exemplary embodiment of the invention will now be discussed in conjunction with the attached drawings in which:

Fig. 1 is a side elevation view of the propellable bridge assembly illustrating a mobile supporting platform, a pair of vertical supports and an enclosed bridge structure according to the prior art;

Fig. 2 is top view of a passenger loading bridge according to the invention and comprising an interface unit, a rotunda, a walkway, a head unit supported by a gantry, and an aircraft interface;

Fig. 3 is side view of the passenger loading bridge of Fig. 2 in an elevated position;

Fig. 4 is side view of the passenger loading bridge of Fig. 2 in a lowered position;

Fig. 5a is an illustration of a passenger loading bridge coupled to a second story terminal gate;

Fig. 5b is an illustration of a passenger loading bridge coupled to a ground level terminal gate;

Fig. 6 is top view of a passenger loading bridge according to the invention and comprising an interface unit, a rotunda, a walkway, a head unit supported by a gantry, and an aircraft interface;

Figs. 7a, 7b, 7c, 7d, 7e, 7f, 7g, 7h, and 7i are diagrams of the rotunda of the passenger loading bridge according to the invention;

Fig. 8 is a diagram of a control console for use with a passenger loading bridge according to the invention;

Figs. 9a, 9b, and 9c are diagrams of a retracting or "flip-out" control console for use with a passenger loading bridge according to the invention;

Figs. 10a, 10b, 10c, 10d, and 10e, are detailed diagrams of the gantry shown in Fig. 2;

Fig. 11 is a method of adjusting aircraft interface height automatically;

Fig. 12 is a flow diagram of a method of aligning the passenger loading bridge with an aircraft;

Fig. 13 is a flow diagram of a method of aligning the passenger loading bridge with an aircraft;

Figs. 14a and 14b are simplified flow diagrams of methods of training the automatic alignment system for the passenger loading bridge and,

Fig. 15 is a simplified diagram of a side of the canopy showing the canopy extension mechanism.

Detailed Description of the Invention

Referring to Fig. 1, a prior art propellable telescoping bridge assembly **10** comprises a forward telescoping bridge section **11**, a rear telescoping bridge section **12**, a forward extension **13**, and a mobile supporting platform **14**. Extending upwardly from upper portion **15** of platform **14** are forward rectilinear support **16** and rear rectilinear support **17**. Such supports are sufficiently wide and deep so as to obviate any necessity for additional vertical supports.

To facilitate positioning of the forward and rear bridge sections **11** and **12**, supports **16** and **17** are provided with hydraulic cylinders **18** and **19** that are independently operable in response to controls such as those represented by control panel **30**. As is known to those skilled in the art, such cylinders extend and retract extending portions **20** and **21** so as to controllably pivot the longitudinal axis of bridge sections **11** and **12** in such manner as to align the forward extension **13** of forward telescoping bridge section **11** with the entry/exit hatch **22** of small aircraft **23**.

Some small aircraft are equipped with moveable stairs that swing downwardly when their entry/exit hatch is opened, and such stair and its associated railing are identified with numerals **24** and **25**. Of course, it will be under- stood that when the bridge assembly **10** is disposed as shown, stairs **24** and railing **25** are not used. As is clear from the drawing, the railings **25** must fit outside the forward telescoping bridge section or they are prone to damage from collisions and the bridge is likely incapable of engaging a side of an aircraft.

Further reference to the front of the forward section **11** reveals the presence of an optional swing down extension that is represented by dashed lines **1la**. Such optional swing down extension may preferably be pivoted by a hinge **11b** that connects it to the floor of extension **11** and is provided so as to accommodate the narrow exit/entry doors that are provided in some small aircraft. Of course, as will be evident to those skilled in the art, a similar hinged swing down extension may optionally be provided at the opposite end of the bridge.

Also shown in FIG. 1 is a conventional large aircraft loading/unloading bridge **26** which is typically supported in part by a conventional wheel **27**. As is known to those skilled in the art, such a conventional bridge is typically equipped with an adjustable forward extension such as extension **28**, and to facilitate engagement therewith, there is provided along the rear terminus of rear bridge section **12**, a conforming curved surface

29. Such conforming curved surface preferably simulates the curvature of a conventional large aircraft (not shown) for which large aircraft loading bridge **26** is designed.

As known to those skilled in the art, telescoping bridge sections are extended and retracted with conventional powered controls, and to facilitate extension and retraction of forward section **11** of the bridge, such conventional controls are provided within section 12 or on the control panel **30** of mobile supporting platform **14**.

When extensions **20** and **21** are extended to different lengths, the bases will tend to swing slightly through small arcs. Accordingly, provision is made to accommodate the swing through the inclusion of conventional swivels or the like (not shown). Provision also is made to secure the bridge, when deployed in its desired position, through the lowering of four hydraulic stabilising jacks that firmly engage upper surfaces of the airport tarmac. Such jacks (represented by jacks **31** and **32**) are preferably located near the four corners of the supporting platform **14** and are controlled by conventional controls that are included among those of control panel **30**.

As is evident upon review of Fig. 1, in order to engage small aircraft, it is essential that conforming curved surface **29** be disposed a significant distance above the tarmac. This enables the extensions **20** and **21** to rest below the rear bridge section **12** above the wheels. Further, stability is provided by the jacks **31** and **32**. These jacks support members and as such are costly. It would be advantageous to design an aircraft passenger bridge that does not need stabilisers in the form of structural members.

Referring to Fig. 2, a top view of an aircraft walkway is shown. A terminal **100** is provided with a plurality of gates. At gate 8 is affixed a passenger loading bridge. The passenger loading bridge comprises an interface unit in the form of a valet unit **102** for connection to the terminal **100**. The valet unit **102** is provided with a service ramp **104** and a passenger ramp **106**. These ramps are well known in the art of passenger loading bridge design. To the valet unit **102** is attached a rotunda **104**. The rotunda **104** comprises

a revolving section **106** for allowing the distant end of the passenger loading bridge to pivot relative to the airport terminal **100** about the rotunda **104**. The rotunda **104** remains enclosed during passenger loading bridge movement thereby ensuring that the passenger loading bridge is protected from the elements. The rotunda comprises edge strip **105** for interfacing with the valet unit **102**, a bellows **107**, and an walkway unit interface **109**.

Attached to the rotunda **104** by way of a hinged connection (shown in Fig. 2) is a walkway section **110a**. Walkway sections **110a, 110b, ..., 110n** are disposed end on end to produce a passenger loading bridge of a desired length. In the drawing of Fig. 1, 3 walkway units are shown. To the end of the walkway units **110** distant the rotunda **104**, is attached a head unit **120**. The head unit **120** comprises a walkway unit similar to the walkway units **110** but provided with additional features. Examples of these features include safety features in the form of an emergency exit stairway **112**, a gantry **130** mounted to the head unit **120**, and an aircraft interface **140**.

As is shown in Fig. 2, the gantry **130** is provided with wheels **132** that allow for lateral motion of the passenger loading bridge. Because the rotunda **104** is fixed and allows rotation of the walkway portion of the passenger loading bridge, moving the gantry **130** causes the entire walkway portion of the passenger loading bridge to swing through the arc shown.

Referring to Fig. 3, a side view of the passenger loading bridge is shown in which the walkway portion is lifted to engage an opening in an aircraft that is 9 feet above the ground. The walkway portion of the passenger loading bridge is elevated using elevators comprising support beams **124** extending vertically on either side of the head unit **120** and an elevator power unit (not shown) in the form of a hydraulic lift. Placing the support beams **124** on either side of the head unit **120** allows head unit **120** to be lowered to level just clearing the gantry frame as is described with reference to Fig. 10 below. The elevator is collinear with the support beams **124** thereby retaining a space below the head unit **120** free of obstruction; this allows the head unit to descend substantially farther than

with devices according to the prior art. The rotunda **104** remains substantially horizontal and the walkway units **110** are angled upward. The hinged connection in the form of bellows **107** between the rotunda **104** and the walkway units **110** is evident. When the head unit **120** is elevated, the emergency exit stairs **113** are extended to allow for emergency exit use. The wheels **132** of the gantry **130** are well below the base of the head unit **120** and the angle of the walkway sections **110** is determined by the desired height of the aircraft interface **140**. Where safety and accessibility for passengers with physical disabilities is of concern, sufficient walkway units **110** are inserted to ensure the angle is not excessive. For a 9 foot rise, a walkway length of about 100 feet including the head unit **120** is desirable.

The head unit is fixedly connected to the walkway unit **110n** at a small angle by connection **122**. As is seen in Fig. 3, the head unit is disposed at a less steep angle than the walkway unit **110n** thereby permitting a more comfortable transition between the aircraft interface **140** and the aircraft entrance (not shown).

Referring to Fig. 4, the tilt of the head unit **120** is shown to allow lowering of the aircraft interface **140** to a level below the top of the gantry wheels **132**. At this height, the emergency exit stairs **113** are collapsed. Preferably, at this height, the stairs **113** are formed into a ramp for serving a same purpose. Lowering the head unit **120** below the top of the gantry wheels **132** allows for a short head unit length to provide the desired reduction in aircraft interface height. Should the gantry **130** always remain below the head unit **120**, a longer head unit is necessary to mate with a lower aircraft opening because the point F is necessarily higher than in the drawing of Fig. 4. Of course, lengthening the head unit or the walkway section of the passenger loading bridge increases overall cost and space required on the apron and is undesirable.

Optionally, the walkway unit **100n** is coupled to the head unit **120** by a hinged connection. The head unit is disposed at a less steep angle than the walkway unit **110n** thereby permitting a more comfortable transition between the aircraft interface **140** and

the aircraft entrance (not shown). In the design shown, this is accomplished using the force of gravity. By placing more of the head unit **120** - by weight - on the side of the gantry **130** proximate the aircraft interface **140** than on the side of the gantry **130** proximate the rotunda **104**, the head unit **120** tilts downward naturally toward the aircraft entrance. Optionally, the head unit **120** is in line with the walkway units.

Current commercially available passenger loading bridges do not support coupling a ground level terminal to an aircraft having a doorway less than 2 feet from the ground. Referring to Fig. 5a, a passenger loading bridge **51** for coupling with a second story of a terminal **50** is shown. The gantry **52**, is disposed to remain below the bottom of the passenger loading bridge **51** even when the passenger loading bridge is lowered to the ground. As such, only the length of the passenger loading bridge is altered to increase or decrease the height of aircraft entrance to which such a passenger loading bridge can be coupled. Referring to Fig. 5b, a ground level terminal **53** is shown coupled to an passenger loading bridge **51**. The passenger loading bridge **51** is capable of being raised and lowered by a gantry **52**. Unfortunately, even when lowered to just clear the gantry **52**, the lowest an aircraft entrance can be is Δx above the ground. Due to the large size of the gantry wheels and the small size of some commuter aircraft, the height Δx is above a base of an entrance for the smaller aircraft.

Alternatively, a plurality of support arms disposed in pairs, each pair hingedly joined at a centre thereof and adjacent pairs joined to one another by connecting an end of each support arm within each pair to a single end of a support arm in an adjacent pair. This forms a scissors like structure for extending and retracting. Devices of this type are well known and understood. A hydraulic or other piston member disposed between pair ends of a first pair, drives the pairs apart or together. Disposing such a device below the head unit, allows the head unit to be raised and lowered through the action of the piston while retaining the a substantially low profile and allowing the head unit to descend to a location substantially proximate a top of the gantry frame. By positioning the support

arms along the longitudinal axis of the head unit, a minimum number of support arms is required since the support arm length can be longer than in the transverse orientation.

Referring to Fig. 6, a detailed top view of the walkway is shown. The interface unit in the form of a valet unit **102** is coupled to the rotunda **104**. The rotunda **104** is shown to revolve about a central point P; this need not be. The gantry wheels **132** are shown angled somewhat beneath the head unit **120** mounted on the gantry frame **134**. This permits comfortable travel through an arc without wheel slippage and extensive tire wear. Also, give in the wheel mount assembly provides greater stability to the hydraulic members for raising and lowering the head unit **120**.

The head unit **120** is provided with an aircraft interface **140** in a side thereof. The aircraft interface **140** is disposed on a telescoping section **124** of the head unit **120** allowing for more accurate alignment of the aircraft interface **140** and the aircraft entrance. The aircraft interface **140** is provided with a bumper **142** along the floor thereof for engaging the outside of an aircraft near the entrance. A gasket **144** surrounding the top and sides of the aircraft interface **140** is for extending to contact the aircraft above the entrance. The gasket **144** serves to protect passengers from the elements while emplaning or deplaning.

Because of the different locations of aircraft entrances, the different sizes of aircraft, and the different curvature of aircraft hulls, the gasket **144** is provided with a number of extenders **146** providing complex motion comprising an angular adjustment and a telescoping means. The combination of the motions allows the gasket **144** to be extended to meet with the hull of the plane at a point above the entrance. Alternatively, the gasket **144** is provided with another form of actuation permitting it to engage the top of the aircraft entrance.

When engaging an aircraft, the header unit **120** is moved proximate the aircraft entrance. The aircraft interface **140** is then aligned with the entrance to the aircraft and the

header unit **120** is moved to engage the aircraft -the bumper **142** contacts the aircraft hull below the aircraft entrance. The gasket **144** is extended to complete the covered walkway from the airport terminal to the aircraft entrance.

When the aircraft is provided with steps on the inside of the door and the steps have a railing - this is common on the Dash 8® - two flaps **148** in the floor of the aircraft interface **140** proximate the bumper **142** are opened to allow the railings from the aircraft to extend through the floor of the aircraft interface **140**. This allows for better positioning of the aircraft interface **140** and improved comfort for passengers emplaning or deplaning from an aircraft provided with steps and a railing.

Controls for the passenger loading bridge are located proximate the bumper **142** to allow for accurate docking with the aircraft and to minimise the potential for damaging the aircraft or passenger loading bridge.

Referring to Fig. 7, detailed drawings of the rotunda are presented. Referring to Fig. 7a, a top view of the rotunda is shown. The rotunda is provided with an edge strip **105** for interfacing with the valet unit **102**. A roof skin **103** covering the rotunda, a bellows **107**, and a walkway unit interface **109**.

Referring to Fig. 7b, a frame structure for the rotunda is shown. The frame is provided with a structural frame **150** mounted on a plurality of levelling jack feet **152**. The levelling jack feet **152** are adjusted during installation and require no further adjustment. This permits the use of inexpensive manual jack feet as are well known in the art. The frame is formed of a base, side walls, and a roof support structure. No pillars or other extraneous supports are used. This provides a clear path through the rotunda **104** during operation. A side coiling curtain **111** (only one of the side coiling curtains is shown at the back of the frame) is disposed around the outside of the rotunda **104** to allow access to render the rotunda **104** substantially impervious to the elements while

permitting entry and exit from the rotunda **104**. The side coil curtain on the front of the rotunda is not shown in Fig. 7b in order to show interior details.

Referring to Fig. 7c, an outside side view of the rotunda **104** is presented. The interface edge strip **105** is coupled to the fixed rotunda frame **104a**. Upon the rotunda fixed frame **104a** rests the rotunda rotating frame **104b**. The rotating frame **104b** is coupled to the walkway unit **110a** (not shown) by way of the bellows **107** and the bellows interface frame **109**. The bellows **107** is supported by the hinged bellows interface frame **109** allowing some angular movement between the walkway unit **110a** and the rotating frame **104b**. The angular movement is better seen in Fig. 3. The side coiling curtain **111** wraps around the outside of the rotunda **104** forming side walls on opposing sides of the frame **150**. When the rotunda rotating frame **104b** is rotated, a side coiling curtain **111** extends while the other side coiling curtain **111** is retracted behind the side coiling curtain exterior skin **111a** and rolled up. The bellows interface frame **109** is supported by a pivot pin **154** held in place by a shaft retainer **156** and allowing for pivotal movement of the bellows interface frame **109** about the pivot pin **154**. This allows for raising and lowering of the head unit **120** without producing excessive stress on the rotunda frames **104a** and **104b**. A cross sectional view of the line EE of Fig. 7a with details of the pivot pin **154** and shaft retainer **156** is shown in Fig. 7d.

Referring to Fig. 7e, a cross sectional view along the roof of the rotunda **104** along line AA of Fig. 7a is shown. The roof skin **103** is shown to form a substantially sealed roof for the rotunda **104** in order to provide comfort for passengers whilst boarding a plane. The roof forms part of the fixed rotunda structure and is attached to the fixed rotunda frame **104a**; it does not rotate. Alternatively, the roof rotates and the fixed rotunda frame **104a** comprises an interface for coupling with the valet unit **102** and a base on which the rotunda rotating frame **104b** rotates.

The roof of the rotunda **104** is supported by the fixed frame **104a**. To the fixed frame 104a is attached the roof skin **103** by a rivet **212**. Below the outer roof skin **103a** is

fibreglass batt insulation **214** separating the outer roof skin **103a** from the inner roof skin **103b**. The roof skin is stretched across the roof from support **216** to support. At each support the roof skin is capped as shown in Fig. 7g. At the rotunda wall proximate the bellows **107**, cove moulding **222** is used to form a visually pleasing seal between the inner roof skin **103b** and the rotating frame **104b**. The rotating frame **104b** is connected to the top bellows closure strip **218** which is in turn connected to the top of bellows **107**. The bellows frame **109** also acts as a support for the rotunda roof support **220** which rests on the bellows frame **109** but is not connected thereto, thereby allowing for relative motion between the rotunda roof and the bellows **107**.

Referring to Fig. 7f, a cross sectional view of the rotunda floor along the line AA of Fig. 7a is shown. The fixed frame **104a** is provided with an interface **105** for adjoining the valet unit **102**. The base of the fixed frame **104a** rests on the ground and is formed of two parallel circular rails **160** and **162** disposed one above the other. The rotating frame **104b** is provided with CAM follower bearings **164** support wheels (not shown) disposed between the rails **160** and **162** and for allowing rotational movement of the rotating frame **104b**. In use, lifting the head unit **120** results in some upward force on the rotating frame **104a** at the end adjacent the walkway unit **110a**. This upward force causes the wheels (not shown)at that end to roll against the upper rail **162**. On the opposing side of the rotating frame **104b**, the wheels (not shown)is forced downward according to known mechanical design principles and rolls on the lower rail **160**. Of course, when no upward force is exerted upon the rotating frame **104b**, the wheels (not shown)all roll along the lower rail **160**. Alternatively, a single circular rail for supporting a plurality of pairs of wheels one wheel from each pair disposed on either side is used for a same purpose.

A platform frame **104c** upon which is rested a plywood floor **104d** forms part of the fixed frame **104a**. Alternatively, floors formed of other suitable material are used. A transition ramp **166** made from a substantially thin material to prevent stumbling is disposed between the plywood fixed floor **104d** and the floor of the walkway unit **110a**

which rotate about the rotunda **104**. As is seen in the drawing, the bellows **107** is coupled at one end to the rotating frame **104b** and at the other end to the bellows interface frame **109** coupled to the rotating frame **104b** by way of the pivot pin **154**.

Referring to Fig. 7g, a drawing of the roof skin seal **103a** is presented. Of course the roof skin **103** can be sealed in any of a number of fashions conventional in the art.

Referring to Fig. 7h, a cross sectional view of the rotunda along the line BB in Fig. 7a is shown. The view affords a detailed view of the side coiling curtain. As can be appreciated from the drawing, the side coiling curtain **111** rolls about a post **171** when the rotating frame **104b** moves such that the side is reduced in length and unrolls to cover the additional exposed siding when the rotating frame **104b** is rotated in an opposite direction. For increased protection and safety, the side coiling curtains **111** roll up inside an enclosure **172**. The far end of the side coiling curtain **111** is fixed to the side wall **174** of the rotunda **104** that forms part of the rotating frame **104b**. As the rotating frame rotates, the side wall **174** pushes or pulls on the side coiling curtain **111**. At an opposing end of the side wall **174** is fixed the bellows **107** and then the bellows interface frame **109**.

Referring to Fig. 7i, a cross sectional view of the rotunda along the line CC in Fig. 7a is shown. The view affords another detailed view of the rotational mechanism of the rotunda.. The fixed frame **104a** is provided with an interface **105** for adjoining the valet unit **102**. The base of the fixed frame **104a** rests on the ground and is formed of two parallel circular rails **160** and **162** disposed one above the other. The rotating frame **104b** is provided with CAM follower bearings **164** support wheels **166** disposed between the rails **160** and **162** and for allowing rotational movement of the rotating frame **104b**. In use, lifting the head unit **120** results in some upward force on the rotating frame **104a** at the end adjacent the walkway unit **110a**. This upward force causes the wheels **166** at that end to roll against the upper rail **162**. On the opposing side of the rotating frame **104b**, the wheels **166** is forced downward according to known mechanical design principles and

rolls on the lower rail **160**. Of course, when no upward force is exerted upon the rotating frame **104b**, the wheels **166** all roll along the lower rail **160**.

Referring to Fig. 8, a diagram of the control panel is shown. The passenger loading bridge disclosed herein is provided with a novel user friendly control layout. The controls are provided in button pairs wherein each button for performing an action and the button for performing an opposite action are adjacent one another, in a predetermined and consistent relation.

Button **251** controls floodlights disposed on the passenger loading bridge (not shown). Button **252** controls the auto leveller feature for levelling the head unit **120**. Buttons **253** control the canopy. As the canopy is moved using 4 separate actuators to control angle and extension on each of the sides of the aircraft interface, each actuator is capable of being individually activated. Also, a group of actuators is capable of being actuated simultaneously. Buttons **255** provide controls for raising and lowering the head unit **120**. Buttons **257** provide for high speed traverse. A large button **258** provides power for the unit and is used mainly in its function as an emergency stop; without power, motion will cease. Each button actuates a function. The function is then controlled by joystick **259**. The joystick allows for a fast and a slow speed of motion. Alternatively, a plurality of speeds in excess of two or an analogue variable speed system is implemented using the joystick **259**. The joystick **259** operates when a button is pressed and has no function in the absence of a depressed button. Of course other configurations of joystick operation are possible and are dependent on safety regulations and concerns.

Using the layout shown in Fig. 8, the buttons are disposed right to left in the order they are required for engaging the loading bridge with the aircraft. Consequently, the buttons are disposed from left to right in the order they are used to disengage the bridge from the aircraft. The joystick operates in an intuitive fashion resulting in selecting at least a button from each group from right to left and moving the appropriate portion of the passenger loading bridge with the joystick until the positioning is as desired. Then, a

next button is selected. In a preferred embodiment, joystick motion is in a direction of walkway motion. For example, moving the joystick to the right causes the gantry wheels to rotated moving the head unit to the right. Moving the joystick forward causes the extensible section of the head unit to extend in a generally forward direction.

Heretofore, control panels for use with passenger loading bridges have been difficult to learn to use. The incorporation of an easy to use control panel and a plurality of sensors as described hereinbelow, allows less experienced operators to manoeuvre the passenger loading bridge with minimum risk of property damage, few safety concerns and little training. Also, training of new operators is rendered less costly because it is unlikely an operator will damage an aircraft so fewer experienced operators can train a plurality of new operators simultaneously. Heretofore, an experienced operator was dedicated to the task of training a new operator until safety of personnel, aircraft, vehicles, and luggage was assured. Further, ergonomic controls result in fewer operator errors and therefore in reduced damage and liability.

Commonly, control panels for use in passenger loading bridges are provided with a plurality of security features such as requiring the pressing of numerous buttons simultaneously in order to actuate the gantry **130**. Referring to Figs. 9a, 9b and 9c, the control panel **200** is provided on a flip out console. The flip out console **200** is mounted on hinges **202** and is held in a first position by latches **204** and in a second "flipped-out" position by a stop **206** (shown in Fig. 9c).

When "flipped-out," controls are activated by pressing a button. The activation continues while a button is pressed and terminates upon releasing all button. For security, once the passenger loading bridge is in place, the console is moved to a "flipped-in" position (shown in Fig. 9a) and the buttons are hidden from view or from accidental activation. Optionally, when in this position, the buttons are disabled. Optionally, a key

lock is provided to disable operation of the control panel or to prevent unauthorised access to the panel.

Referring to Fig. 10, the gantry **130** comprises a platform **134**. The platform **134** is structural and is capable of supporting the weight of the lifted portion of the passenger loading bridge. The gantry platform **134** supports two support beams **124** (not shown) on either side of the head unit **120** for raising and lowering the head unit **120**. The support beams **124** are fitted with a vertical power unit **138** in the form of a hydraulic drive to provide power for lifting and for lowering the head unit **120** in a controlled fashion. Because the support beams **124** are disposed beside the head unit **120**, the head unit **120** can be lowered to rest on the gantry frame **134**.

To the gantry **130** are also connected two pairs of wheels **132**. Two of the wheels **132a** are driven for moving the gantry **130** laterally. The other two wheels **132b**, disposed at the opposing end of the gantry **130** provide stability during motion of the gantry **130** and during rest. The wheels **132** are supported by axles **133** disposed above the frame **134**. The placement of the wheels **132** above the gantry frame **134** allows a simple rectangular frame construction and permits the head unit **120** to be lowered to a level substantially near the ground. Further, the gantry configuration shown in Figs. 10a, 10b, 10c, 10d and 10e allows extremely large gantry wheels **132** without raising the minimum height of the head unit **120**. Large wheels are desirable when obstacles such as uneven ground or pot holes are of concern. Large wheels also permit the support of heavier structures.

Because the radius of curvature of the gantry **130** during lateral movement is fixed, the wheels **132** are turned in slightly to accommodate the arc that is traversed during movement of the passenger loading bridge.

As is seen in Fig. 10b the gantry frame **134** is disposed above the ground by a clearance distance D to allow for unobstructed motion in the lateral direction when the

wheels **132** are driven. The gantry frame construction is dependent upon the weight of the passenger loading bridge requiring support. Therefore, the minimum height of the passenger loading bridge at the gantry **130** is the clearance distance D plus the frame thickness T plus the thickness of the passenger bridge underside and floor. This distance is also determinative of the lowest aircraft entrance with which the passenger loading bridge can engage.

Since the gantry frame **134** extends beyond the sides of the head unit **120**, there is a potential that the gantry wheels **132** could damage an aircraft by hitting the aircraft steps or the like. Therefore, the gantry **130** is positioned behind the aircraft interface **140** by a sufficient distance to clear any steps, railings, and propellers of supported aircraft. Alternatively, the aircraft interface **140** extends from an end of the passenger loading bridge instead of at a right angle and allows for the opening and the wheels to not interfere with each other.

Of course, it is evident from the drawings that when the wheels **132** are disposed beneath the aircraft interface **140** that the aircraft interface **140** can not be lowered below the top of the wheels **132**. This is undesirable. Disposing the wheels **132** on either side of the head unit **120** and on either side of the aircraft interface **140** requires a substantial structural support frame for the gantry **130** and is therefore, less desirable than the embodiment shown in the figures. Also of note is that the hydraulic power unit presents the same concerns. Disposing the hydraulic unit beneath the walkway is, therefor, undesirable. As can be seen in the figures, the hydraulic power unit is disposed on a side of the head unit **120** and not beneath it when the head unit is fully lowered.

Optionally, the rotunda **104** is elevated above ground level. This requires an interface unit **102** that slopes upward from the terminal **100** to the rotunda **104**. With a configuration as shown in Fig. 1, the additional sloped element allows for an extra 2 feet of aircraft interface elevation and allows the aircraft interface **140** to be positioned lower than with the rotunda **104** at ground level. Preferably, when the rotunda **104** is positioned

2 feet above the ground, a base is placed below the rotunda **104**, the base having a larger diameter than the rotunda **104**. This base increases rotunda stability.

Referring to Fig. 11, a method of automatically adjusting the height of a passenger loading ramp is shown. An operator enters an aircraft type and where applicable an entrance on the aircraft. The control panel comprises a processor and non-volatile storage. In the non-volatile storage is a table of information regarding entrances to each aircraft. The selected aircraft entrance is located in the table and a height is determined. The height is provided to the elevation means and the aircraft interface 140 is raised to substantially that height. Such a process reduces operator effort and improves efficiency by accurately aligning the bridge with the aircraft entrance height automatically.

Referring again to Fig. 6, a detailed drawing of the head unit **120** shows a plurality of sensors **230** disposed about the periphery of the head unit. These sensors serve a variety of functions described hereinbelow.

It is uncommon to use a passenger loading bridge with small aircraft. As described above, clearance between aircraft features such as propellers and entrances are significantly less than with jumbo jets. Because a passenger loading bridge often costs orders of magnitude less than aircraft, there is considerable concern over aircraft damage. Aligning a bridge with an entrance of a small aircraft is very difficult and prone to error. An obvious way of accomplishing this task is having an individual communicating by radio to indicate to an operator current status and problems. In order to obviate the individual, a window was placed in the passenger loading bridge. Unfortunately, due to small clearances between the aircraft entrance and propeller and some features extending beyond the sides and end of the passenger loading bridge, sufficient view to prevent damage consistently was not afforded by the window.

Due to the high cost of damage to an aircraft in terms of customer dissatisfaction, delays, insurance, possible injury, etc., it is imperative that engaging the aircraft entrance

be accomplished with minimum risk to an aircraft. For Jumbo jets this was not an issue due to significant clearance between the jets and the entrance; however, without a reliable system for preventing aircraft damage, passenger loading bridges are unlikely to gain acceptance with small aircraft.

The sensors **230r** are disposed adjacent the handrail slots **148** in the floor of the aircraft interface **140** proximate the bumper **142**. The sensors detect a presence and/or location of an object proximate the bumper. Examples of sensors that are suited for such an application include sonar, proximity detector sensors, electromagnetic sensors, light beam sensors disposed at a plurality of locations to detect the presence of an opaque object breaking a beam of light, etc. Further sensors **230p** are disposed in locations along the side of the passenger loading bridge where the bridge may strike an aircraft propeller. Other sensors **230s** are disposed to detect the presence of people or vehicles on the tarmac and in the path of the passenger loading bridge during positioning. Of course, many other sensor locations are used depending on common collisions or near collisions and on the intended use of the passenger loading bridge and its sensors. The sensors are used in any of a number of ways some of which are outlined below with reference to Figs. 13-15.

Referring to Fig. 12, a simplified flow diagram of a method of engaging the aircraft interface **140** with an aircraft entrance is shown. The type of aircraft is provided to the control panel. The input for this is provided by a keyboard or mouse as is conventionally used with personal computers. Alternatively, a dial is provided for selecting a height or an aircraft type. The bumper **142** is automatically raised to a known height for the selected aircraft. At this height, the bumper should engage the aircraft substantially below the entrance thereof. The gantry **130** is swung into place proximate the aircraft slowly. As the gantry approaches the aircraft, the extensible section of the head unit **120** is extended or retracted to align the aircraft interface **140** and the entrance to the aircraft. The gantry **130** again is used to move the head unit **120** to engage the aircraft. When a sensor detects the presence of an object proximate the passenger loading

bridge in a location where no object should correctly be, the operator is informed of this fact. For example, when an object such as a railing is detected 6 inches from the railing slot **148** along the bumper, the operator is appraised of this information and can stop the gantry and extend or retract the extensible portion of the head unit to ensure proper alignment. Upon achieving proper alignment, the sensors provide feedback to the operator that such is the case.

Similarly, while operating the gantry to swing the passenger loading bridge into position, the sensors may detect an aircraft propeller. The cost of hitting an aircraft propeller with a passenger loading bridge is significant, and the additional safety feature of sensors disposed at outlying points on the passenger loading bridge provide an advantage of increased safety by detecting collisions with people, reduced property damage and consequently improved efficiency. These and other advantages will be evident from this disclosure.

Referring to Fig. 13, a simplified flow diagram of a method of automatically aligning the passenger loading bridge of Fig. 12 with the entrance of an aircraft is shown. Preferably, the control system for the passenger loading bridge is trained according to known training techniques in order to optimise alignment for a particular installation. Training of passenger loading bridges is discussed below. The aircraft type is provided by an operator. The operator need not be on the bridge and often, the operator is not at the airport terminal. When all flights are scheduled at a central location, the central location provides the aircraft type to the loading bridges using a communications network. Optical, wireless or digital communications networks such as an Ethernet network are applicable to this method.

The gantry **130** is controlled to raise the aircraft interface to the known height for aircraft of the type provided. A method similar to that of Fig. 11 is used. Alternatively, during training, aircraft heights are learned and incorporated into the alignment procedure for each aircraft. Once at the known height, the gantry **130** is swung slowly toward the

aircraft. When learning has occurred, the aircraft interface **140** is extended to a predetermined optimal extension. When learning has not been used, preferably, the aircraft interface **140** is extended completely or retracted completely. During the swinging of the passenger loading bridge, sensors **230** disposed at a plurality of locations on the bridge, detect a presence or absence of objects in the path of the bridge. When an object is detected, the gantry **130** is stopped and the head unit **120** is extended until the object is cleared or until it is fully extended. When fully extended, the head unit **120** returns to its previous extension and indicates an error and a location of the object that is causing the problem. An operator is then required to clear the object from the path before engagement can proceed. Of course, should the object move on its own, the bridge controller indicates all clear and waits a predetermined length of time to ensure safety before moving. Then the engagement process continues.

It is evident to those of skill in the art that when the object is detected at the free end of the head unit **120**, the head unit **120** is not extended further but may be retracted in some instances.

As the aircraft interface **140** approaches the aircraft, the sensors **230** detect the presence of the aircraft. Preferably a more accurate sensor 230u such as an ultrasound sensor is used to align the bumper **142** and the entrance to the aircraft. The use of a distance measuring sensor such as ultrasound, enables the readings of other sensors to be evaluated for accuracy and for potential problems. Of course, at no point on the passenger loading bridge except the bumper **142** should contact with the aircraft occur so the absence of a range sensor does not prevent application of the method of Fig. 14. Once aligned, the control system indicates such and an operator traverses the passenger loading bridge into the aircraft to ensure correct engagement. Then passengers can emplane or deplane. Optionally, once aligned, the head unit **120** is raised or lowered a small amount to determine if the height was in fact correct and to more precisely engage the base of the aircraft entrance. In an embodiment, the auto-leveller performs this function.

In another embodiment, the entrance to the aircraft is fitted with a transmitter in the form of an RF transmitter for providing a wireless signal. The passenger loading bridge is provided with a sensor for sensing the transmitted signal, for determining a location of the transmitter, and for moving the aircraft interface toward the signal source. Absent, sensors **230**, the passenger loading bridge is liable to strike a wing, propeller, or other part of the aircraft during motion. It is, therefore, preferable that the passenger loading bridge have disposed thereon sensors **230** for detecting the presence of objects proximate the loading bridge. The sensors **230** also increase safety.

It is apparent to those of skill in the art that placing a transmitter at the entrance to an aircraft is far less time consuming than engaging a passenger loading bridge to an aircraft entrance. As such, efficiency is improved.

Referring to Fig. 14a, a method of training the automatic alignment system is presented. Over a period of several months, an experienced operator enters the aircraft type to be engaged and proceeds to manually engage the aircraft. With each engagement, data is collected indicative of typical engagement practices for each aircraft type. This method is suitable for use with an expert system.

Referring to Fig. 14b, another method of training the automatic alignment system is presented. The system is adapted for use with neural networks or other learning systems based on machine intelligence. For each aircraft, an attempt is made by the system to engage the aircraft. The attempt may follow a method similar to that outlined with reference to Fig. 13. Errors in the engagement are noted by an operator and provided to the control system. The control system incorporates these "errors" into its learning process. Over time, it is expected that the engagement accuracy should improve and that operator verification of engagement and further entry of errors is obviated. Training in such a manner allows the engagement method design to remain generic while training compensates for specific issues that arise at a particular location or terminal.

In an embodiment, the automatic alignment system comprises a neural network of a conventional type. The network comprises a plurality of nodes including input nodes, output nodes and an optional number of hidden nodes. Neural network design is well known in the art of computer science and more particularly in the art of machine learning. Some signals from sensor are provided to input nodes and control signals are provided as outputs. Disposed therebetween is a series of weighted summing nodes for determining the control signals in dependence upon the input signals. During training, the weighted summing nodes are modified in a manner to provide the desired output control signals in response to predetermined input signals.

In training, a plurality of alignments of the passenger loading bridge and the entrance to different types of aircraft are performed by experienced operators. With each alignment, the neural network gathers information and correlates the information to produce a trained control system. Neural network information gathering and training is well known in the art of machine learning. The training comprises weighting nodes of the neural network in order to generate responses to input information that substantially match responses provided with the training set for same input information.

When the sensors are for safety reasons and not intended for use in automatic engagement, the sensors 230 sense a presence of an object. When the object is likely to be hit by the passenger loading bridge - the object is in the path of motion of the bridge - one of the horizontal pivot means, the elevation means, and the horizontal pivot means and the elevation means is stopped. Selection of which to stop is dependent upon where the object is detected and a direction of the bridge's motion. When the object is no longer in the path of the passenger loading bridge, motion is resumed. Alternatively, when an object is detected, the bridge is moved so as to avoid the object but continue toward engaging the aircraft; when this is not possible, bridge motion is stopped.

Referring to Fig. 15, a diagram of the canopy extender 146 is shown. The canopy 144 is formed of conventional bellows. The extender 146 is formed of a supporting arm

146a hingedly connected to the aircraft interface 140 at a hinged connection 146b. Coupled between the supporting arm 146a and the aircraft interface 140 is an hydraulic piston 146c swinging the supporting arm 146a about the hinged connection as shown at arrows S. To the supporting arm is coupled an end of a secondary arm 146d by a second hinged connection 146e. The secondary arm is swung about the second connection 146e by a second hydraulic piston 146f and swings through the arc L when the supporting arm is stationary. The opposing end of the secondary arm is coupled to the canopy 144.

In use, moving pistons 146c and 146f causes the canopy to moved according to a complex motion comprising both forward and downward motion. Preferably, supporting arm 146a provides substantially horizontal movement while secondary arm 146d provides substantially vertical movement of a top edge of the canopy 144.

Numerous other embodiments of the invention are envisaged without departing from the spirit and scope of the invention.

Claims

What is claimed is:

1. A passenger loading bridge for interconnecting an aircraft having an entrance therein with the ground level of an airport terminal building comprising:

a walkway-conduit including:

a first open end,

an extensible section proximate an opposing end thereof comprising an aircraft interface for mating with the aircraft entrance,

elevation means for elevating the aircraft interface to allow the aircraft interface to engage each of a plurality of different sized commuter aircraft,, and

horizontal pivot means for pivoting the walkway about a rotunda;

the rotunda having a first open end coupled to the airport terminal building substantially at ground level and a second open end movable relative to said first open end of the rotunda, the second open end hingedly connected to the first open end of the walkway for allowing the rotunda to remain substantially level and for allowing the aircraft interface to be elevated, wherein the horizontal pivot means is for moving the second open end of the rotunda relative to the first open end of the rotunda..

2. The passenger loading bridge as defined in claim 1 wherein the walkway comprises:

a first walkway portion hingedly coupled to the rotunda; and

a second walkway portion connected to the first walkway portion and angling downwardly from the connection when the first walkway portion is lowered to a fully lowered position, the second walkway portion having the aircraft interface disposed proximate an end thereof..

3. A passenger loading bridge as defined in claim 1 wherein the open end of the rotunda is connected to two substantially circular rails disposed one above the other and wherein

the second open end in the rotunda is connected to a plurality of bearings disposed between the rails and each for rolling on one of the bottom rail and the top rail at a given time.

4. A passenger loading bridge as defined in claim 4 wherein the horizontal pivot means comprises a frame and wherein the elevation means is disposed in a location one of above or beside the conduit for allowing the walkway to be lowered to substantially abut a top of the frame of the horizontal pivot means..

5. A passenger loading bridge as defined in claim 1 wherein the aircraft interface comprises a bumper disposed along the bottom of the aircraft interface for engaging the aircraft below the entrance, a gasket disposed substantially above the aircraft interface for engaging the aircraft above the entrance and for forming a protective covering for passengers passing between the aircraft and the passenger loading bridge.

6. A passenger loading bridge as defined in claim 6 wherein the bottom of the aircraft interface comprises a plurality of slots for accepting railings disposed on staircases proximate the aircraft entrance and forming part of the aircraft.

7. A passenger loading bridge for interconnecting an aircraft having an entrance therein with the ground level of an airport terminal building comprising:
a walkway conduit including:

a first opening at an end thereof,
an extensible section proximate an opposing end thereof comprising an aircraft interface for mating with the aircraft entrance,
elevation means for elevating the aircraft interface to allow the aircraft interface to engage each of a plurality of different sized commuter aircraft,
horizontal pivot means for pivoting the walkway about a rotunda, and

sensors for detecting the presence of an object proximate the walkway and for providing signals in dependence thereon;

the rotunda having a first opening connected to the airport terminal building substantially at ground level and a second opening movable relative to said first opening of the rotunda, the second opening hingedly connected to the first opening in the walkway for allowing the rotunda to remain substantially level and for allowing the aircraft interface to be elevated, wherein the horizontal pivot means is for moving the second opening of the rotunda relative to the first opening of the rotunda; and,

means responsive to the signals provided by the sensors for stopping at least one of the horizontal pivot means and the elevation means when an object is detected in a path of motion of the walkway.

8. A passenger loading bridge as defined in claim 7 wherein the means responsive to the signals comprises means for resuming motion of the at least one of the horizontal pivot means and the elevation means when the object is no longer detected in the path of motion.

9. A passenger loading bridge as defined in claim 7 wherein the means responsive to the signals comprises means for automatically aligning the aircraft interface and the entrance in dependence upon an indication of a type or size of aircraft and the signals.

10. A passenger loading bridge as defined in claim 7 wherein the aircraft interface is extensible in a substantially perpendicular direction to the direction of lateral motion of the walkway.

11. A passenger loading bridge as defined in claim 7 wherein the sensors comprise a light source and a detector disposed to form a beam of light along an edge of the walkway, the

detector for detecting a presence or absence of light from the light source reaching the detector.

12. A method of automatically aligning the aircraft interface of the passenger loading bridge as defined in claim 7 and an entrance to the aircraft comprising the steps of:
determining an approximate height of the entrance;
moving the aircraft interface to substantially the approximate height;
moving the aircraft interface toward the aircraft;
detecting a presence of objects in the path of movement of the passenger loading bridge using sensors;
moving portions of the passenger loading bridge to avoid detected objects;
in the presence of objects, stopping the passenger loading bridge motion until objects are cleared;
upon approaching the aircraft, aligning the bumper of the aircraft interface with the entrance; and
moving the aircraft interface to engage the aircraft with the bumper.

13. A method of automatically aligning the aircraft interface and the entrance to an aircraft as defined in claim 12 wherein the step of determining an approximate height of the entrance is performed by indicating an aircraft type and selecting a height corresponding to the aircraft type from stored values of aircraft heights.

14. A method of automatically aligning the aircraft interface and the entrance to an aircraft as defined in claim 12 wherein the step of determining an approximate height of the entrance is performed by indicating parameters relating to the aircraft dimensions.

15. A method of automatically aligning the aircraft interface and the entrance to an aircraft as defined in claim 12 wherein the step of moving the aircraft interface toward the

aircraft is performed by extending an end of the passenger loading bridge proximate the aircraft interface.

16. A method of automatically aligning the aircraft interface and the entrance to an aircraft as defined in claim 12 wherein the step of detecting a presence of objects in the path of movement of the passenger loading bridge using sensors is performed using sensors disposed at a plurality of locations about an outside surface of the passenger loading bridge.

17. A method of automatically aligning the aircraft interface and the entrance to an aircraft as defined in claim 12 wherein the step of upon approaching the aircraft, aligning the bumper of the aircraft interface with the entrance is performed in dependence upon a separate imaging sensor for identifying the entrance and detecting a location of the entrance.

18. A method of automatically aligning the aircraft interface and an entrance to an aircraft as defined in claim 12 wherein the step of upon approaching the aircraft, aligning the bumper of the aircraft interface with the entrance is performed in dependence upon a sensor for detecting railings on the aircraft stairs and a known location of slots for accepting the railings.

19. A method of automatically aligning the aircraft interface and the entrance to an aircraft as defined in claim 12 wherein some of the steps are performed in dependence upon previous training data.

20. A method of automatically aligning an aircraft interface of a passenger loading bridge and an entrance to an aircraft as defined in claim 19 wherein the steps are performed in by a controller comprising a neural network.

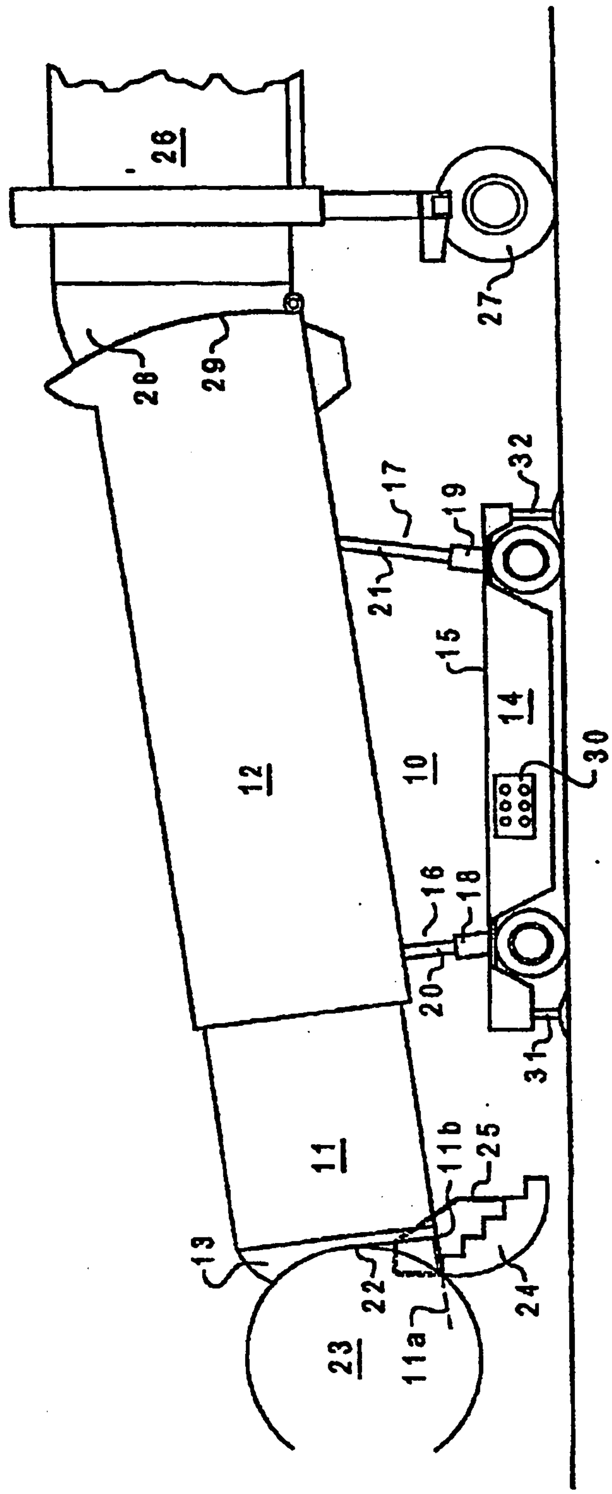
26
27
28
29
17
19
32
21
15
14
30
12
10
16
18
20
31
11
11b
25
13
22
24
23
11a

Fig. 1

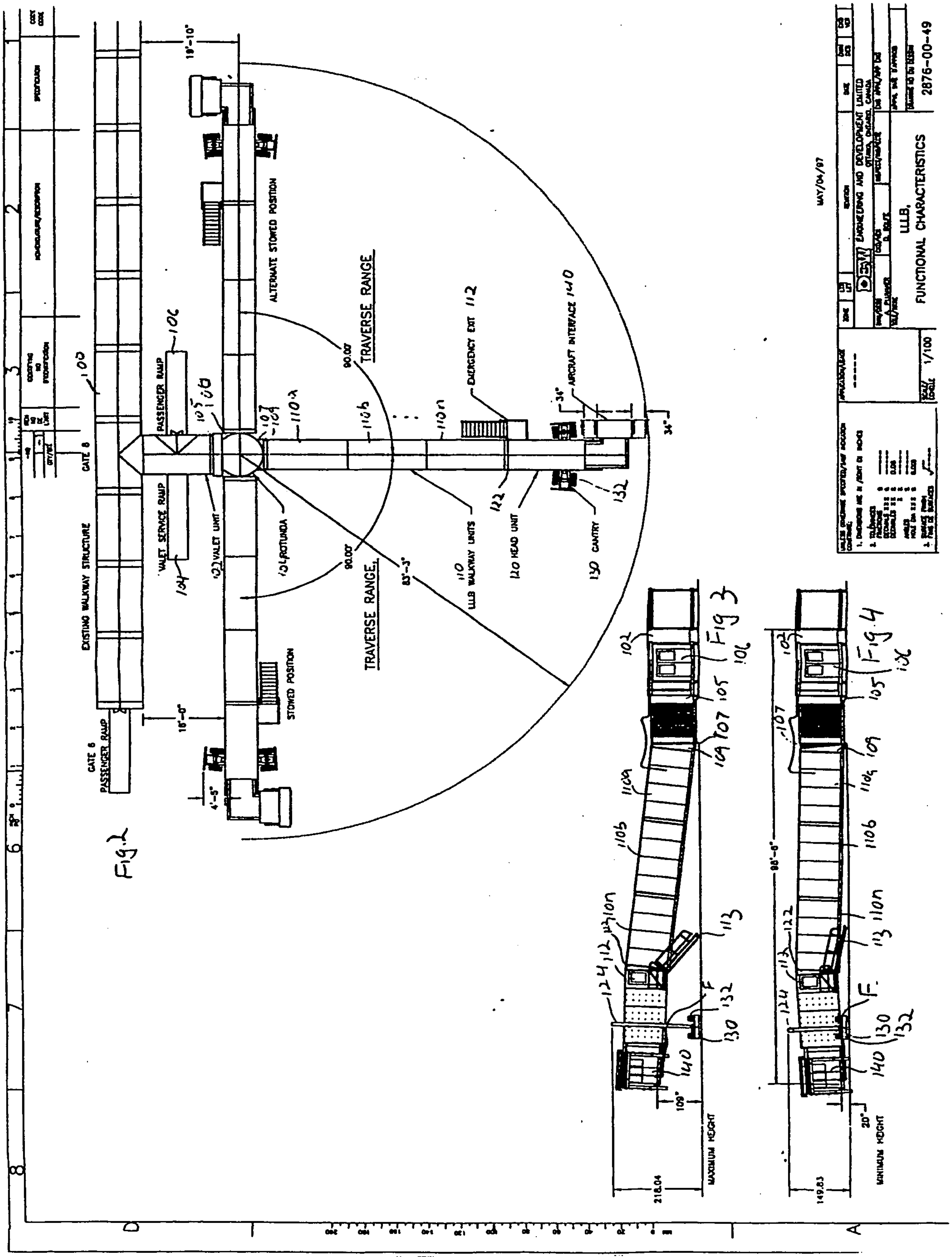
Fig 2
EXISTING WALKWAY STRUCTURE
GATE 8
GATE 6
PASSENGER RAMP
PASSENGER RAMP
VALET SERVICE RAMP
VALET UNIT
ROTUNDA
ALTERNATE STOWED POSITION
STOWED POSITION
TRAVERSE RANGE
TRAVERSE RANGE
EMERGENCY EXIT 112
AIRCRAFT INTERFACE 140
LLLB WALKWAY UNITS
120 HEAD UNIT
130 GANTRY
19'-10"
16'-0"
4'-5"
83'-3"
90.00
34"
Fig 3
Fig 4
MAXIMUM HEIGHT
MINIMUM HEIGHT
218.04
149.83
LLLB,
FUNCTIONAL CHARACTERISTICS
2876-00-49
1/100
MAY/04/97

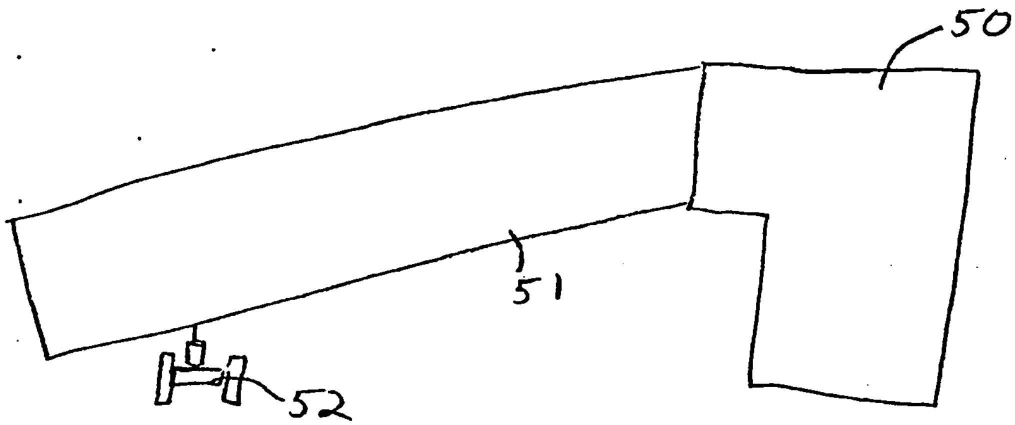

Fig. 5a

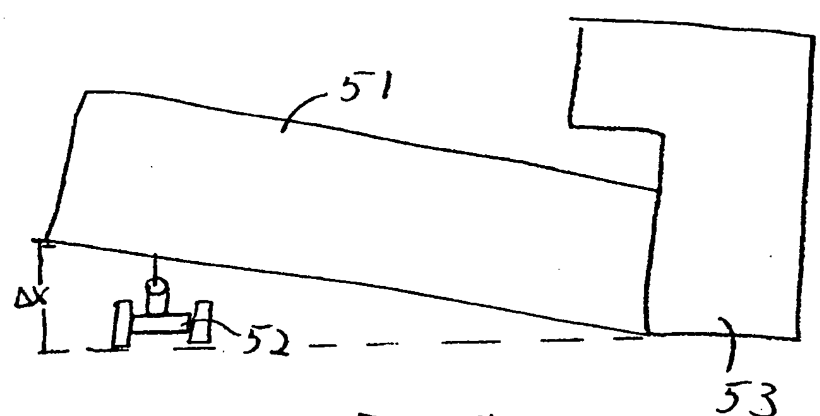

Fig. 5b

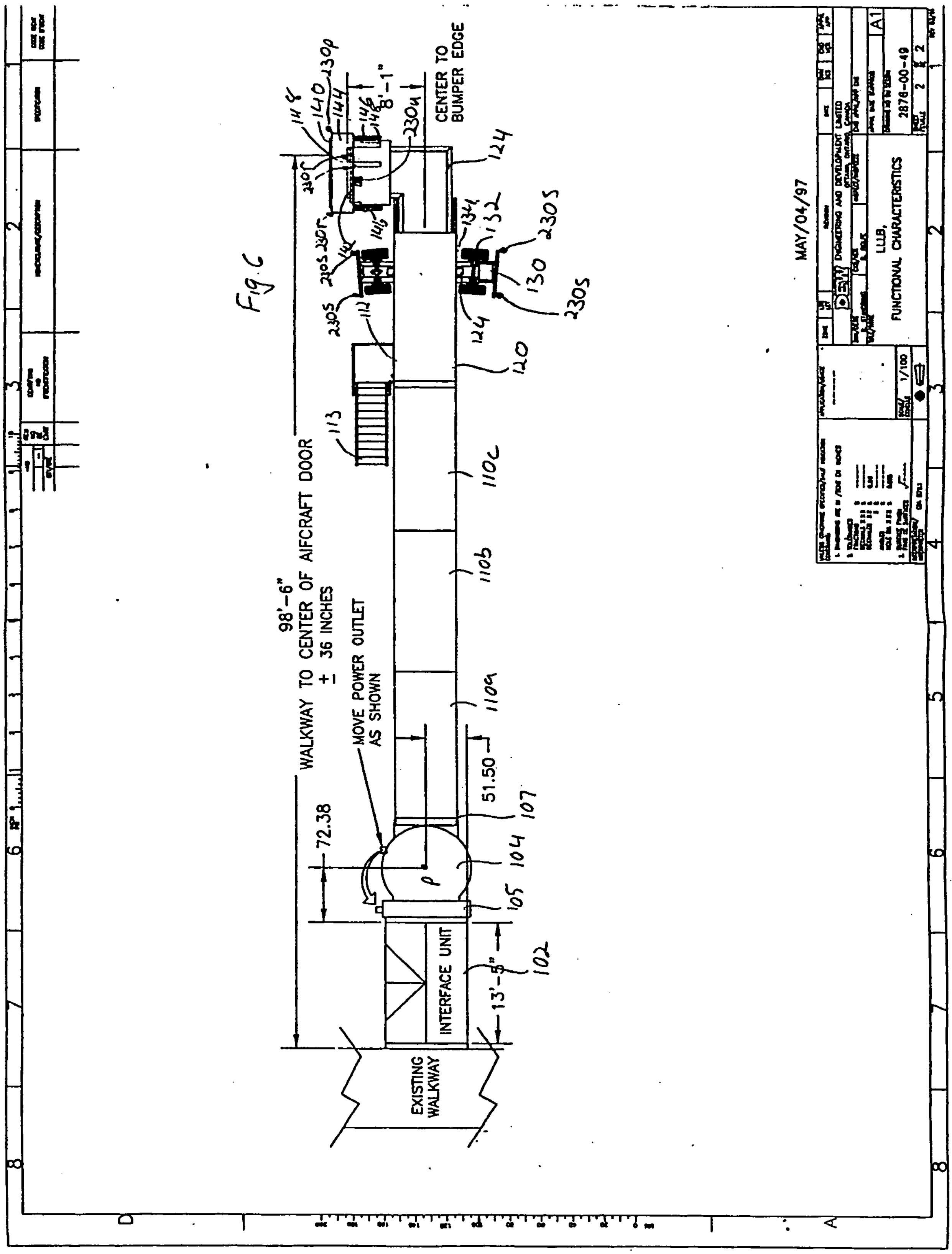
Fig. 6
98'-6"
WALKWAY TO CENTER OF AIFCRAFT DOOR
± 36 INCHES
CENTER TO BUMPER EDGE
8'-1"
MOVE POWER OUTLET AS SHOWN
72.38
51.50
13'-5"
INTERFACE UNIT
EXISTING WALKWAY
MAY/04/97
LLLB,
FUNCTIONAL CHARACTERISTICS
2878-00-49
1/100
A1
102
104
105
107
110a
110b
110c
112
113
120
124
130
132
134
140
142
144
146
148
230p
230q
230r
230s

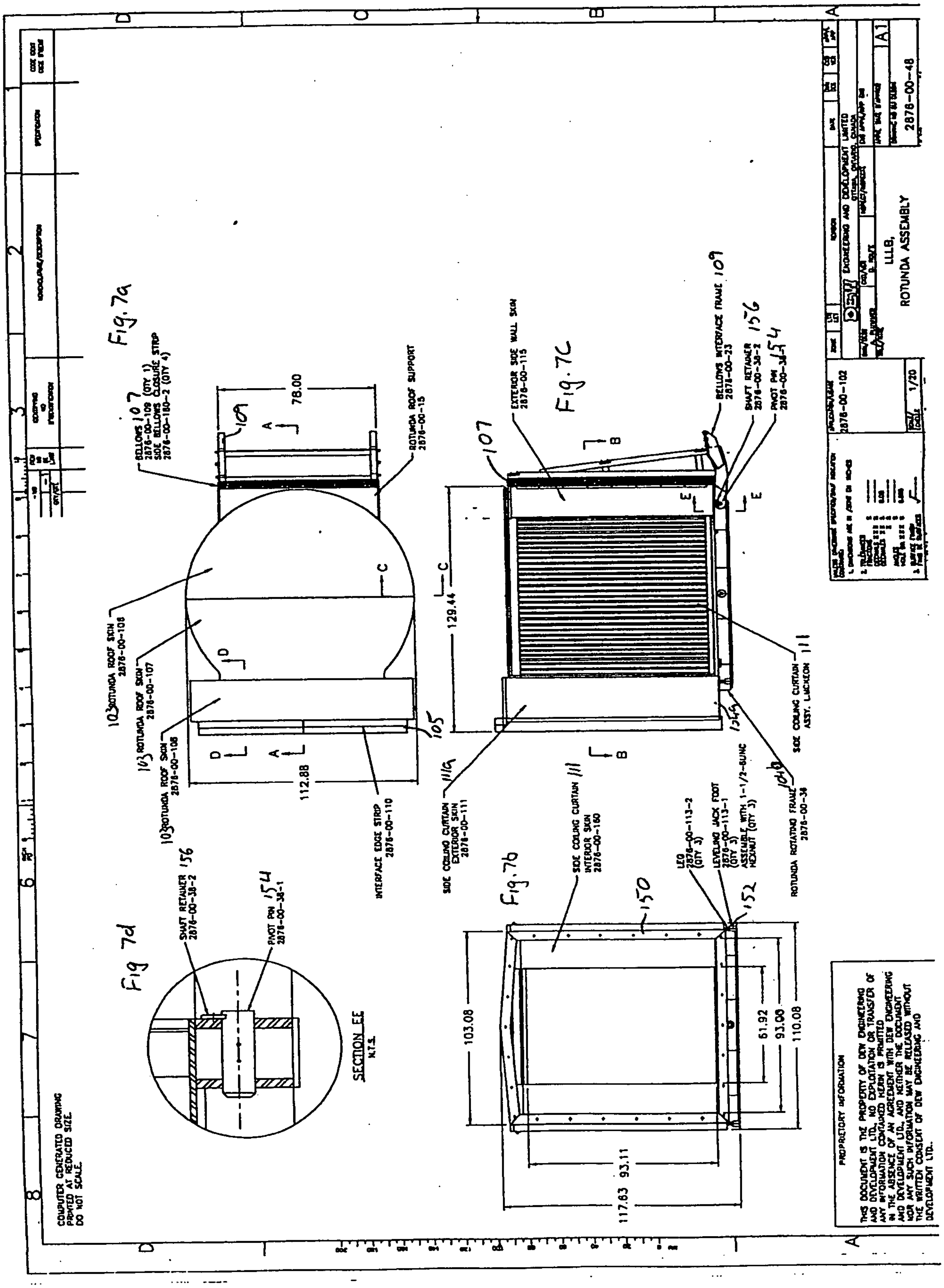
Fig. 7a
Fig. 7b
Fig. 7c
Fig 7d
BELLOWS 107
2876-00-109 (QTY 1)
SIDE BELLOWS CLOSURE STRIP
2876-00-180-2 (QTY 4)
ROTUNDA ROOF SUPPORT
2876-00-15
103 ROTUNDA ROOF SKIN
2876-00-108
103 ROTUNDA ROOF SKIN
2876-00-107
103 ROTUNDA ROOF SKIN
2876-00-106
INTERFACE EDGE STRIP
2876-00-110
78.00
112.88
129.44
EXTERIOR SIDE WALL SKIN
2876-00-115
BELLOWS INTERFACE FRAME 109
2876-00-23
SHAFT RETAINER 156
2876-00-38-2
PIVOT PIN 154
2876-00-38-1
SIDE COILING CURTAIN 111
ASSY. LINCKEON
SIDE COILING CURTAIN
EXTERIOR SKIN
2876-00-111
SIDE COILING CURTAIN 111
INTERIOR SKIN
2876-00-180
LEG
2876-00-113-2
(QTY 3)
LEVELING JACK FOOT
2876-00-113-1
(QTY 3)
ASSEMBLE WITH 1-1/2-6UNC
HEXNUT (QTY 3)
ROTUNDA ROTATING FRAME
2876-00-34
SECTION EE
N.T.S.
103.08
117.63
93.11
61.92
93.00
110.08
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DEW ENGINEERING AND DEVELOPMENT LIMITED
OTTAWA, ONTARIO, CANADA
LLLB,
ROTUNDA ASSEMBLY
2876-00-102
1/20
A1
2876-00-48

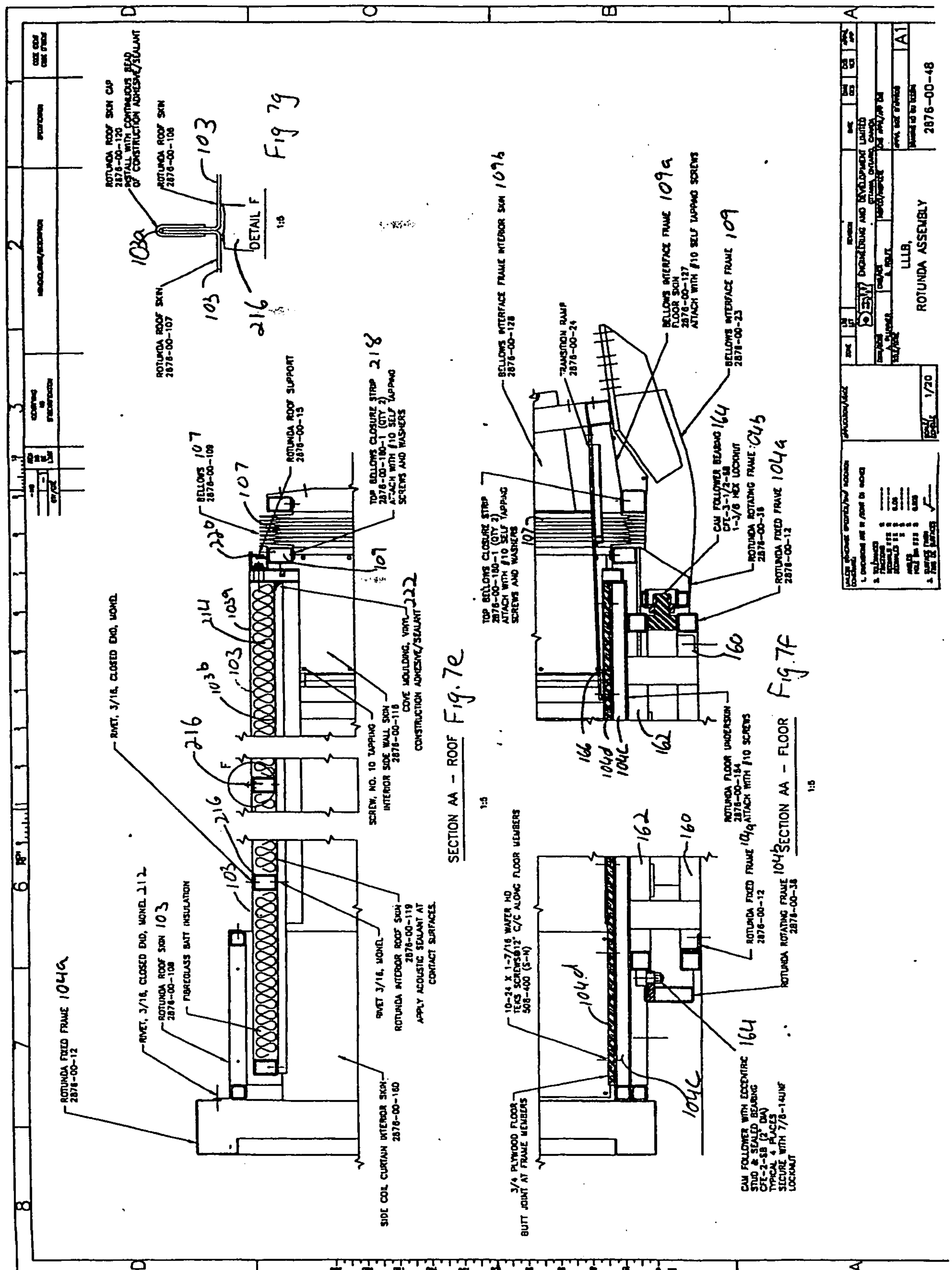
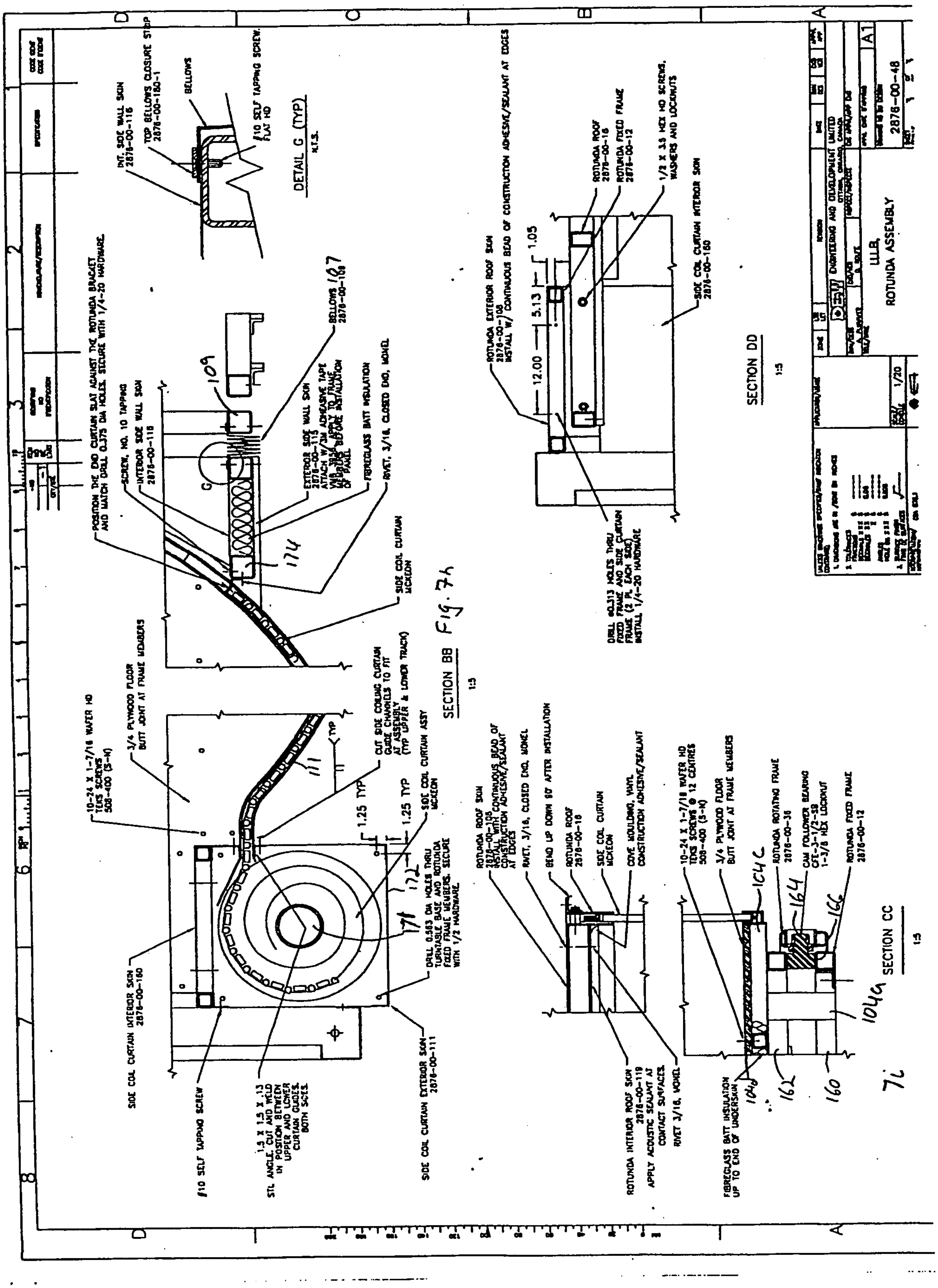


Fig. 7e

Fig. 7F

Fig 7g


DETAIL G (TYP)
SECTION DD
SECTION BB
SECTION CC
Fig. 7h
7i
ROTUNDA ASSEMBLY
2876-00-48

2876-00-218

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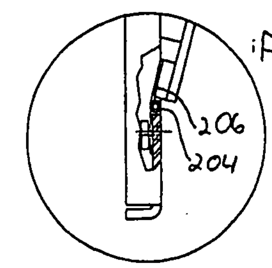
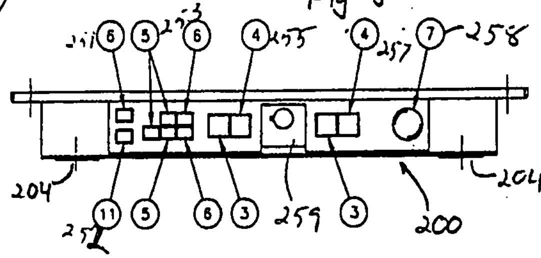


Fig 9c

DETAIL A
SCALE: 1/1

Fig 8



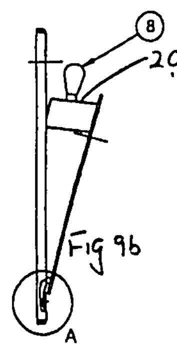
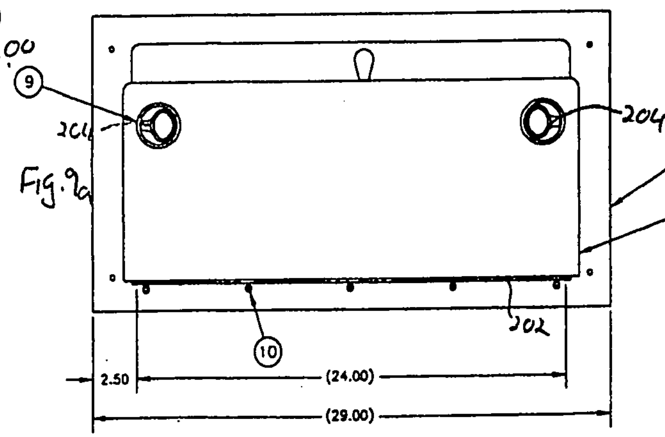


Fig 9b

Fig. 9a



QTY/QTÉ	ITEM NO L'ART	IDENTIFYING NO D'IDENTIFICATION	NOMENCLATURE/DESCRIPTION	SPECIFICATION	CODE IDENT CODE D'IDENT
1	1	2876-00-183	CONTROL PANEL FRAME		
1	2	2876-00-185	SWITCH PANEL ASSEMBLY		
2	3	800A-M 2H B 24C	PUSH BUTTON, LARGE SQUARE, BLUE, IEC STYLE (ALLEN-BRADLEY INDUSTRIAL CONTROLS)		
2	4	800A-M 2H C 24C	PUSH BUTTON, LARGE SQUARE, CLEAR, IEC STYLE (ALLEN-BRADLEY INDUSTRIAL CONTROLS)		
3	5	800A-M 2G B 24C	PUSH BUTTON, RECTANGULAR, BLUE IEC STYLE (ALLEN-BRADLEY INDUSTRIAL CONTROLS)		
3	6	800A-M 2G C 24C	PUSH BUTTON, RECTANGULAR, CLEAR, IEC STYLE (ALLEN-BRADLEY INDUSTRIAL CONTROLS)		
1	7	800T-N307A	PUSH BUTTON,PUSH-PULL/TWIST JUMBO RED, NEMA STYLE (ALLEN-BRADLEY INDUSTRIAL CONTROLS)		
1	8	800T-T4T8AAXX	TOGGLE SWITCH, 4 WAY, NEMA STYLE, SPRING RETURN OPERATION (ALLEN-BRADLEY INDUSTRIAL CONTROLS)		
2	9	M1-61	LATCH, FLUSH-PULL (BLACK)		SOUTHCO
5	10	1876	SCREW, MACHINE, FLAT HD, PHILLIPS DR, 10-24UNC-2A X 0.50 LG, STL, ZN PLD		94223
1	11	800A-M 2G R 24C	PUSH BUTTON, RECTANGULAR, RED, IEC STYLE (ALLEN-BRADLEY INDUSTRIAL CONTROLS)		

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	A2	REVISED	97-04-02	AM		
	A1	REVISED	96-10-07	R.R.S.		

UNLESS OTHERWISE SPECIFIED/SAUF INDICATION CONTRAIRE
1. DIMENSIONS ARE IN/DIMENSIONS SONT EN INCHES
2. TOLERANCES
FRACTIONS ± ------
DECIMALS/DECIMALES .XXX ± ------
.XX ± 0.06
.X ± ------
ANGLES ± ------
HOLE DIA .XXXX ± 0.005
3. SURFACE FINISH/FINI DE SURFACES √ ------
INTERPRETATION/INTERPRETER CSA B78.1

APPLICATION/USAGE 2876-00-87

SCALE/ECHELLE 1/4

DEW ENGINEERING AND DEVELOPMENT LIMITED
OTTAWA, ONTARIO, CANADA

DWN/DESS A. MACPHEE | CHKD/VER D. ROLFE | INSPECT/INSPECTÉ | ENG APPVL/APP ING

TITLE/TITRE CONTROL PANEL ASSEMBLY

APPVL DATE D'APPROB | A2

DRAWING NO DU DESSIN 2876-00-218

SHEET/FEUILLE 1 OF/DE 1

REV 03/95

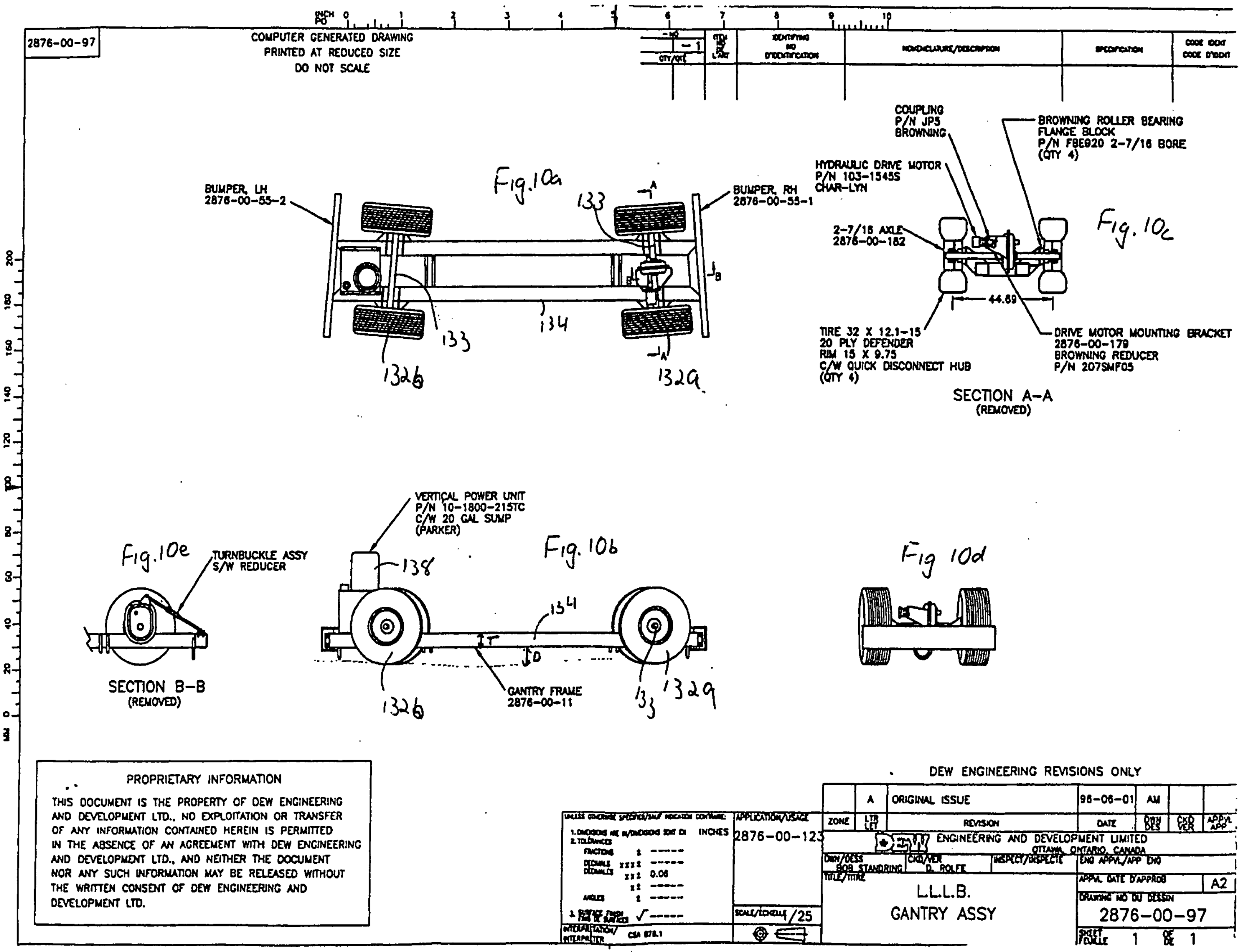
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Fig.10a
BUMPER, LH
2876-00-55-2
BUMPER, RH
2876-00-55-1
133
134
132b
132a
COUPLING
P/N JP5
BROWNING
BROWNING ROLLER BEARING
FLANGE BLOCK
P/N FBE920 2-7/16 BORE
(QTY 4)
HYDRAULIC DRIVE MOTOR
P/N 103-1545S
CHAR-LYN
2-7/16 AXLE
2876-00-182
Fig. 10c
44.69
TIRE 32 X 12.1-15
20 PLY DEFENDER
RIM 15 X 9.75
C/W QUICK DISCONNECT HUB
(QTY 4)
DRIVE MOTOR MOUNTING BRACKET
2876-00-179
BROWNING REDUCER
P/N 207SMF05
SECTION A-A
(REMOVED)
VERTICAL POWER UNIT
P/N 10-1800-215TC
C/W 20 GAL SUMP
(PARKER)
138
Fig. 10b
Fig.10e
TURNBUCKLE ASSY
S/W REDUCER
SECTION B-B
(REMOVED)
GANTRY FRAME
2876-00-11
Fig 10d
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CKD/VER D. ROLFE
INCHES
APPLICATION/USAGE 2876-00-123
SCALE/ECHELLE /25
CSA B78.1
L.L.L.B.
GANTRY ASSY
A2
DRAWING NO DU DESSIN
2876-00-97
SHEET 1 OF 1

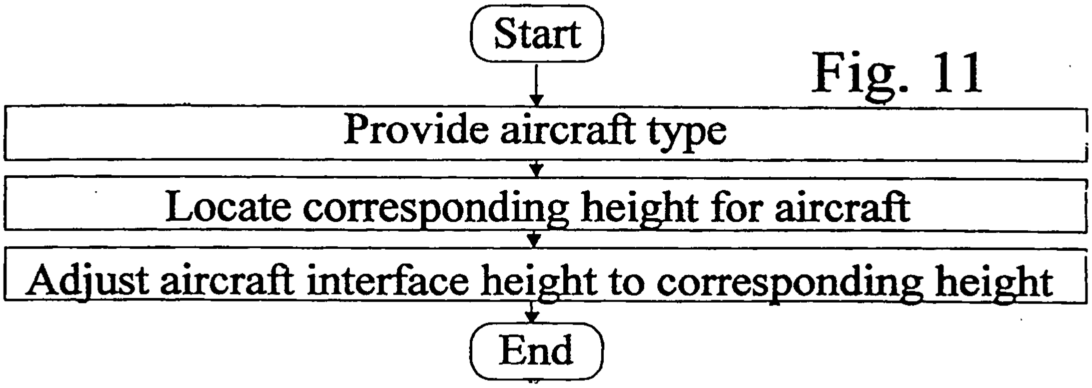

Start
Provide aircraft type
Locate corresponding height for aircraft
Adjust aircraft interface height to corresponding height
End

Fig. 11

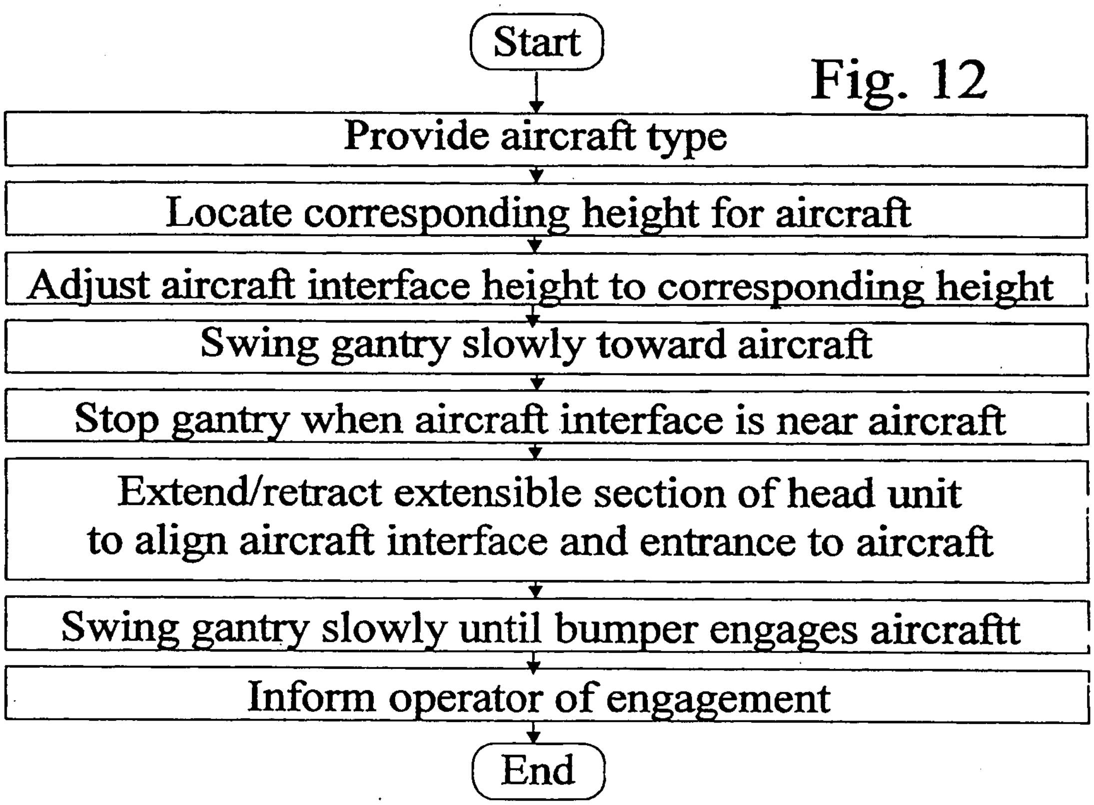

Start
Provide aircraft type
Locate corresponding height for aircraft
Adjust aircraft interface height to corresponding height
Swing gantry slowly toward aircraft
Stop gantry when aircraft interface is near aircraft
Extend/retract extensible section of head unit
to align aircraft interface and entrance to aircraft
Swing gantry slowly until bumper engages aircraftt
Inform operator of engagement
End

Fig. 12

Fig. 13

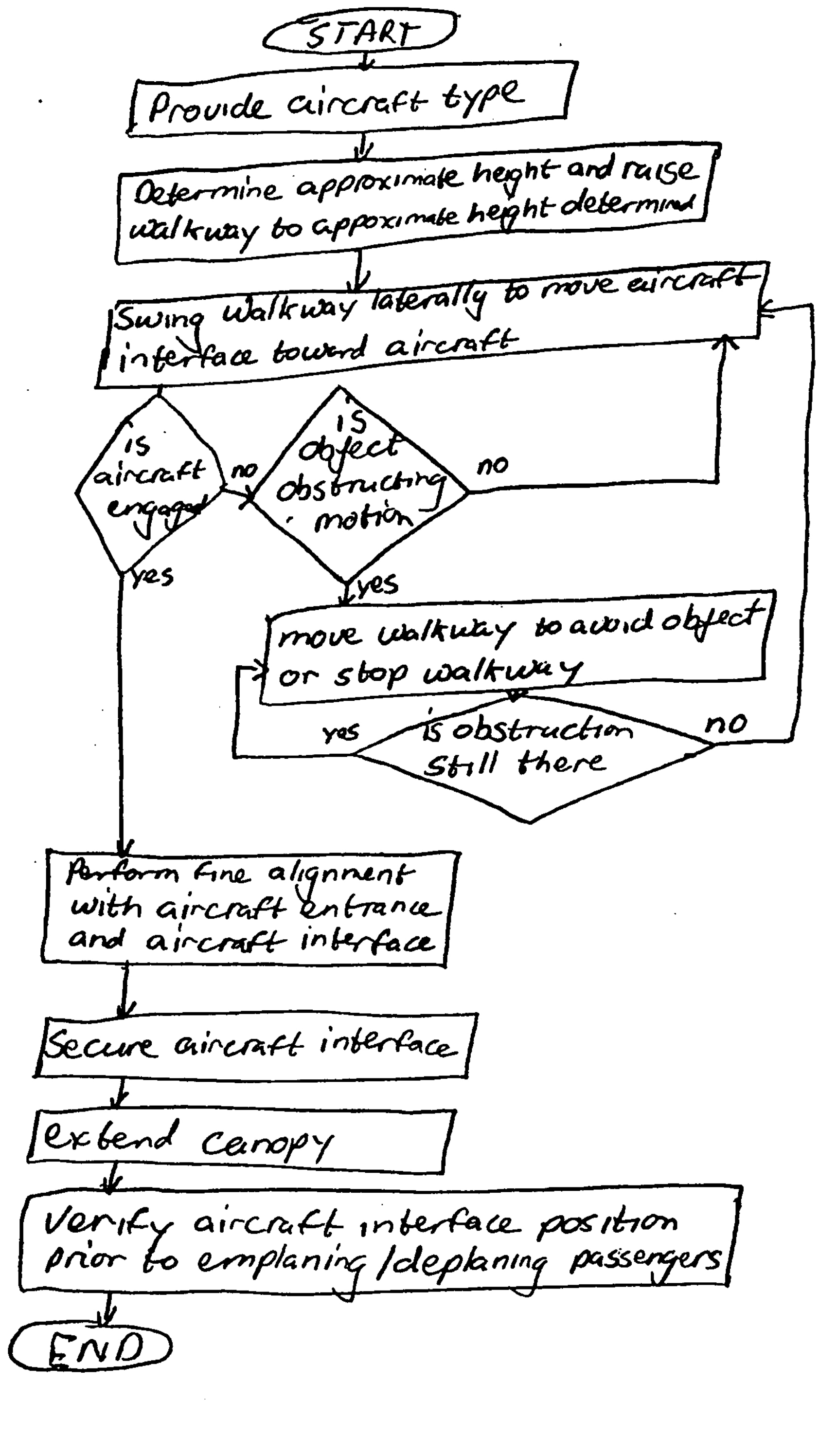
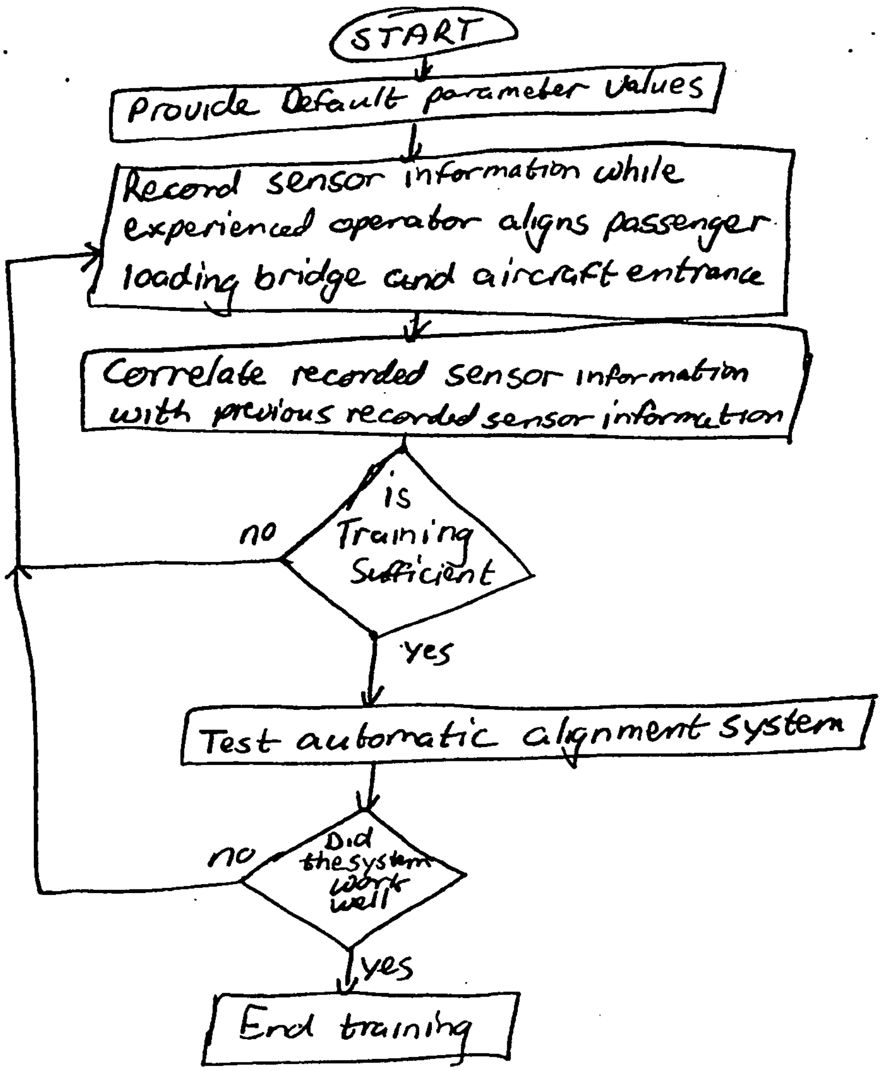

START
Provide aircraft type
Determine approximate height and raise walkway to approximate height determined
Swing walkway laterally to move aircraft interface toward aircraft
is aircraft engaged
no
yes
is object obstructing motion
no
yes
move walkway to avoid object or stop walkway
is obstruction still there
yes
no
Perform fine alignment with aircraft entrance and aircraft interface
Secure aircraft interface
extend canopy
Verify aircraft interface position prior to emplaning/deplaning passengers
END

Fig. 14a


START
Provide Default parameter values
Record sensor information while experienced operator aligns passenger loading bridge and aircraft entrance
Correlate recorded sensor information with previous recorded sensor information
is Training Sufficient
no
yes
Test automatic alignment system
Did the system work well
no
yes
End training

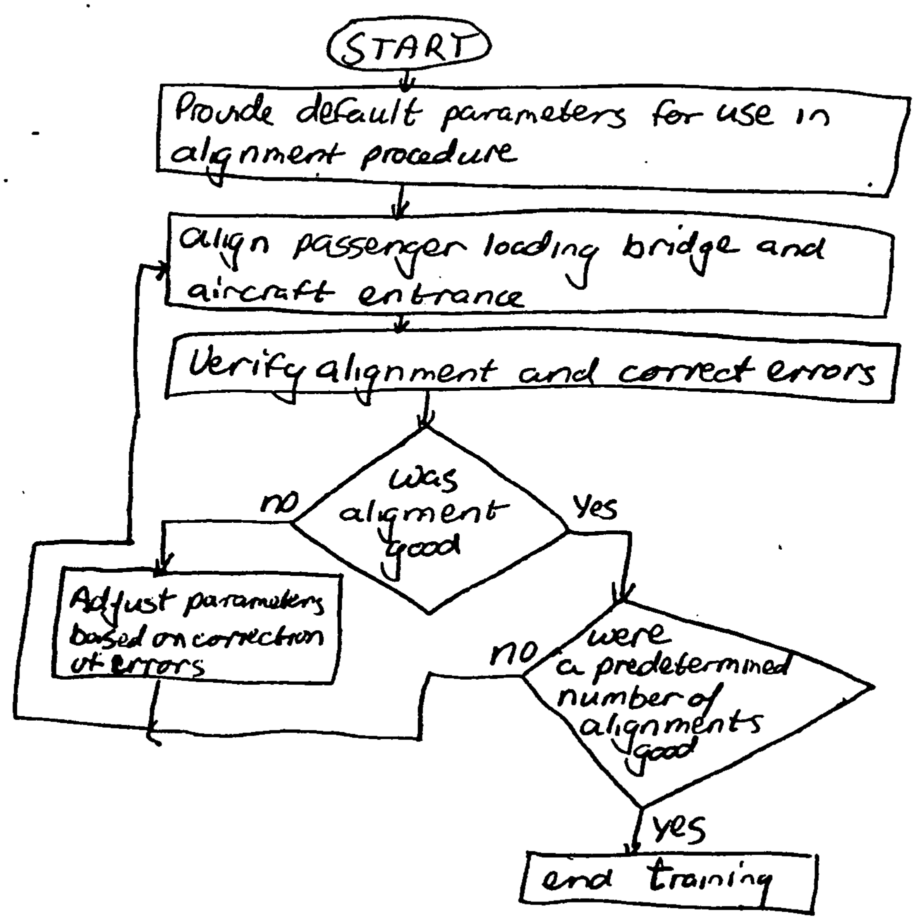

START
Provide default parameters for use in alignment procedure
align passenger loading bridge and aircraft entrance
Verify alignment and correct errors
Was alignment good
no
yes
Adjust parameters based on correction of errors
were a predetermined number of alignments good
no
yes
end training

Fig. 14b

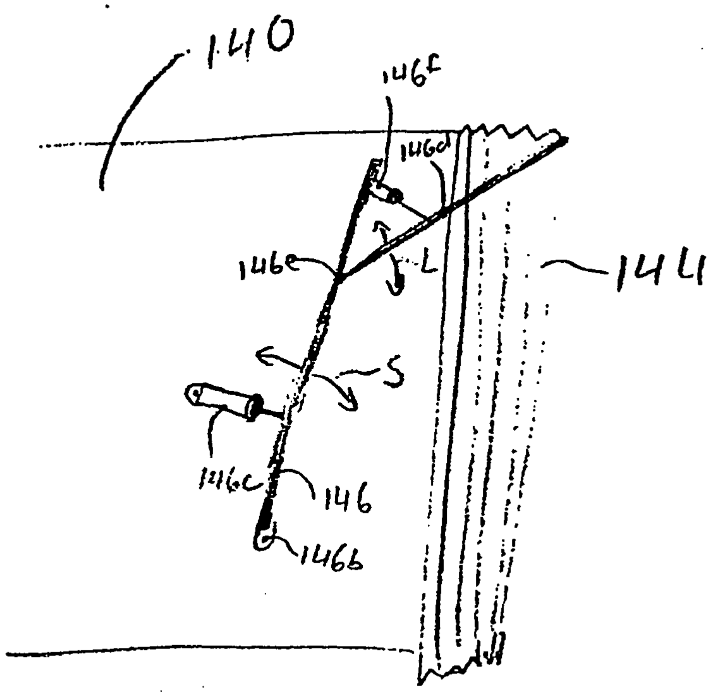


Fig. 15